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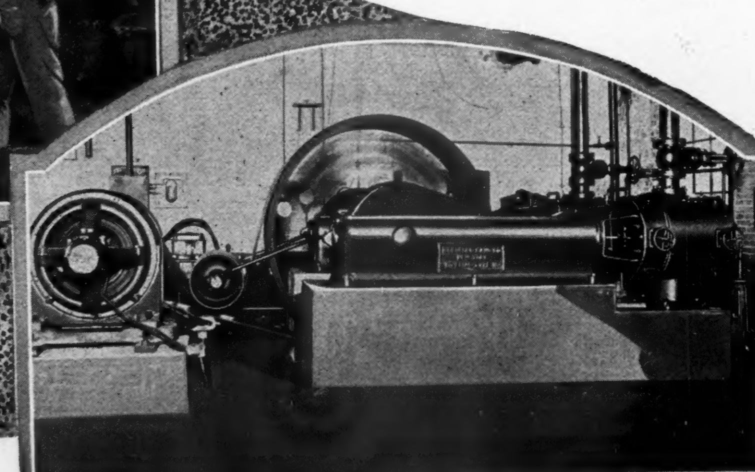

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VOL. XXVIII, NO. IV

APRIL, 1923

The Diamond Industry

A Survey of the World's Progress in the Mining and in the Use of Diamonds as Gems and in Industry

By RICHARD HOADLEY TINGLEY

THE DIAMOND—composed of pure carbon; the hardest thing in Nature; known to the Greeks as "adamas" and to the Romans as "diamas"; possessing qualities that withstand time and eternity—is, today, the same changeless, undimmed, gleaming, fascinating thing of beauty as it was a thousand years ago.

To the popular mind, the diamond suggests opulence, adornment, luxury. It has other uses, however, of a strictly industrial character, that are of more practical value to mankind.

In this article, the author tells the story of the diamond—where it is found; where and how it is mined; of the part played by compressed air in its mining operations; of its production; of its value as a gem; and of its usefulness in industry.

UNTIL about 200 years ago, India was the exclusive source of the world's supply of diamonds; and from its ancient mines of Golconda came all the famous gems of history. In India was found the "Kohinoor" that so long held the center of the stage as the world's greatest diamond. Although this stone has since been eclipsed in size and in brilliancy by many others—the "Cullinan," the biggest gem of 3,205 carats, the "Excelsior," and the "Jubilee"—its name still stands in the popular mind for all that is rare, big, and beautiful in diamonds. India still produces diamonds; but in that field it is no longer a factor of much importance.

Diamonds were first found in Borneo, about the year 1700, where they were, and still are, won from washings of the rivers that flow from the western slopes of the Ratoos Mountains. This island, however, cuts but a small figure in the world's supply. In small quantities, although often of excellent quality, diamonds are garnered and mined—usually from river washings—in Australia, the Belgian Kongo, British and Dutch Guiana, Venezuela, Lapland, and Russia.

As a diamond producer, the United States is a negligible quantity, but as a consumer it ranks high, as evidenced by the fact that we imported 534,530 carats of uncut diamonds, valued at $38,222,524, and 1,407,140 carats of cut diamonds, worth $165,806,506, during the past four years. The twelvemonth of 1919 was by far the biggest year in this business, with an importation of 290,797 carats of uncut diamonds, valued at $20,315,758, and 525,559 carats of cut diamonds, worth $64,222,947. Our country imposes a tariff of 10 per cent. on uncut stones and of 20 per cent. on stones cut but not set. Diamond dust, "bort," and black industrial diamonds are admitted free of duty. More than half of these stones come to us from Amsterdam—the home of diamond cutting—where, for generations, the lapidaries have attained such a degree of excellence in the art that others have found it difficult to compete. In the United States, however, diamond cutting is an industry of much importance.

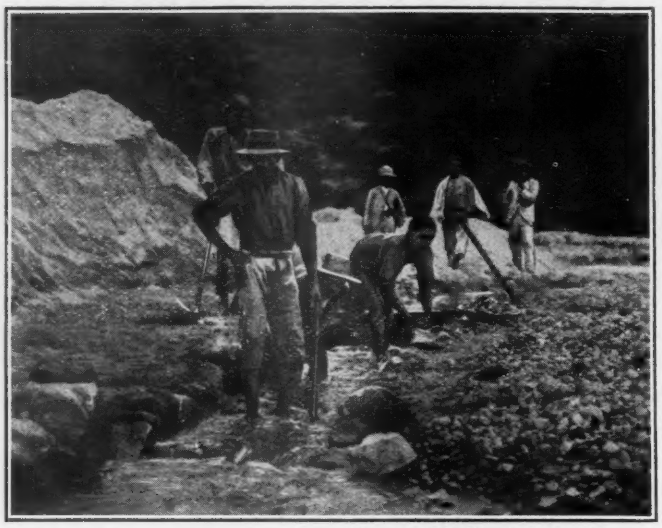
The principal source of diamonds in the United States is Pike County, Ark., where these gems have been known to exist and have been mined in a more or less haphazard fashion for several years. It is generally conceded that there is a potential field in Arkansas for procuring both gems and industrial diamonds once the operations are placed on an efficient basis. Stones ranging as high as 6½ carats (a carat is about 3.13 troy grains) have been won from these mines; and many of them have be n cut and set by Tiffany & Company who have pronounced the gems of excellent quality. The United States Geological Survey reports that the production of diamonds here, mostly in Arkansas, was valued at $16,453 for the 5-year period ending December, 1918. Since then the output has been negligible.

Diamonds were discovered in Brazil, in the early part of the eighteenth century, by miners who were washing the river beds for gold. From that time on Brazil has been an important factor in that industry; and many thousands of carats have been taken from the rivers of Bahia and Minas Geraes. The most primitive methods are still practiced in Brazilian diamond mining. The gravel is taken from the beds of the streams by natives, and is washed by hand. The only mechanical implements used are the crowbar, the pick, and the hammer. The principal mining sections are at Diamantina and along the upper reaches of the Paraguassu and other rivers, 100 or 200 miles inland from the coast, with approaches through the ports of Bahia and Caravellas.

No statistics are available of Brazil's total diamond output for any given year. It is known, however, that in 1920 the State of Bahia collected an export tax on 2,820,375 carats of industrial diamonds, a large portion of which were black diamonds—pure carbon. Brazil labors under a severe handicap as a competitor in the diamond market. Taxes are heavy, roads are poor, and freight rates are high. In the interior, where the mines are located, food and supplies are expensive, and labor is scarce. Notwithstanding these drawbacks, many beautiful and costly stones come out of Brazil every year.

South Africa stands preëminent in the production of diamonds. From the mines situated there now come approximately 80 per cent. of the world's supply, and if Africa, including the Belgian Kongo and Southwest Africa, be taken as a whole, it may safely be said that from 90 to 95 per cent. of the world's annual output is accounted for.

Diamonds were discovered in South Africa by school children, in 1867, on the premises of a Boer farmer close to the present town of Barkly West, on the Vaal River. Little at-



Courtesy Diamond Drill Carbon Company.

Diverting a stream in Brazil to uncover diamondiferous gravel.

Courtesy Diamond Drill Carbon Company.

Diamond "panning" in a Brazilian stream.

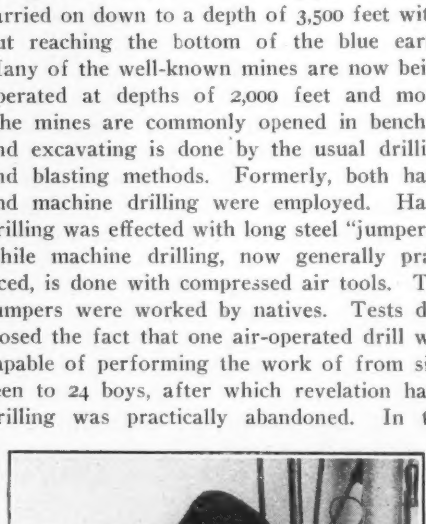
tention was attached to the incident until a couple of years later, when a magnificent white stone, of 83½ carats, was accidentally picked up by a shepherd near the Orange River. Following this, diamond hunting in South Africa became something more than a haphazard pastime: prospectors, adventurers, and capitalists streamed in, and a conventional diamond rush, similar to the oft-repeated gold rushes, was on. The outcome has been the establishment of a diamond mining industry on a thoroughly scientific and systematic basis after years of prospecting and experimenting, during which time the mother lode of the diamond was discovered in many places.

South Africa and diamond mining are now inseparably connected in the minds of most of us. Intimately associated also with the diamond industry are such names of the world-famous mines as DeBeers, Kimberley, Wesselton, Bultfontein, Dutoitspan, Jagersfontein, Premier, and Robert Victor. The finest gems known to the trade are often sent out under the name of the mine from which they come. They are further graded, according to their value, into "Jagers," "Wesseltons," top crystals, crystals, top silver capes, silver capes, capes, top brown, light green, yellow, and brown. Some of the big steel-white gems are valued at from $2,000 to $3,000 a carat.

Not only do the famous mines and mine owners of South Africa control the output of diamonds, but they control as well, through the London Diamond Syndicate, the price and the release of stocks. This syndicate, together with Belgian-Kongo interests and those in Southwest Africa, practically dominates the entire diamond industry of the world, Brazil excepted.

Scientific prospecting in South Africa finally disclosed the true source of all diamonds to be a certain "blue ground," now known as "kimberlite." Ages ago volcanic action had pushed this earth upward through immense chimneys or "pipes." These are enormous fissures, or open chasms of unsounded depth, into which Nature had forced, from subterranean regions, slow-moving rivers of this blue ground containing the world's richest deposits of diamonds. As this soft mixture oozed into the bottoms of the chimneys, it was gradually driven upward, filling the chasms from wall to wall and to the top, where its progress was ended by hardening in the shape of a small mound, or "kopje," ten or a dozen feet higher than the surrounding surface. The presence of one of these mounds is almost a sure indication of a diamondiferous pipe.

Exploration work in these pipes has been carried on down to a depth of 3,500 feet without reaching the bottom of the blue earth. Many of the well-known mines are now being operated at depths of 2,000 feet and more. The mines are commonly opened in benches, and excavating is done by the usual drilling and blasting methods. Formerly, both hand and machine drilling were employed. Hand drilling was effected with long steel "jumpers," while machine drilling, now generally practiced, is done with compressed air tools. The jumpers were worked by natives. Tests disclosed the fact that one air-operated drill was capable of performing the work of from sixteen to 24 boys, after which revelation hand drilling was practically abandoned. In the



Courtesy Brown & Sharpe Mfg. Company.

Hand grinding with carbon-pointed tool.

Premier mine the installation of 84 pneumatic drills enabled doing away with 2,300 native employees who formerly operated the jumpers.

Compressed air now performs many of the tasks previously done by hand and by straight steam. For all underground service in the mines, for driving shafts, for mechanical haulage, for rock drills, and for other machinery where power is necessary, steam has been supplanted by compressed air, much as it has in other mining operations elsewhere throughout the world. In the Premier mine it was found that blasting left the blue earth in large lumps or slabs. These were formerly broken up by boys with hand hammers. This work is now being done almost entirely with pneumatic hammers.

The diamond-bearing blue ground, as it comes from the mine, is automatically dumped into ore bins, and thence conveyed in trucks, drawn by endless wire ropes, to the receiving floor that is rolled hard as if for a tennis court. In some of the mines, these floors are several miles in length and have a width of from 600 to 800 feet, the earth being spread out upon them about a foot in thickness. In these great layers of blue ground lie the diamonds—invisible to the ordinary observer. Nature steps in here and weathers the mass—a process often requiring from six months to a year.

When thoroughly disintegrated, the earth is hauled to washing machines to enter the first stage of concentration. Automatic water feeders supply the washing machines, and the wet mixture goes thence through chutes into revolving cylinders perforated with holes about 1¼ inches in diameter. The pulverized earth which passes through the perforations, is fed into shallow pans where the contents are swept around by revolving arms that force the diamonds and other heavy material to the sides of the pans. The contents of the pans are next conveyed to a pulsator, where the mass is sifted into several different sizes ranging from ⅙ to ⅝ of an inch in diameter. The heaviest part of the earth, containing the diamonds, passes through the screens into pointed boxes from which it is drawn off and taken to sorting tables smeared with grease. Only the dia-

monds adhere to the grease; and they are thus readily recovered. This is the last stage in the reclaiming process. The diamonds are then sorted, and are ready to be shipped to the market. Just about 1 per cent. of the total amount of washed earth finds its way to the pulsator, and approximately 58 per cent. of this is waste.

PRODUCTION OF DIAMONDS IN SOUTH AFRICA

PRODUCTION FROM MINES

	Carats	Estimated Value	Value per carat
1913	4,944,946	£10,254,203	41s. 6d.
1914	2,653,089	4,906 342	37s. 0d.
1915	2,131	3 887	36s. 6d.
1916	2,170,348	4 769,479	43s. 11d.
1917	2,710,941	6,659 721	49s. 2d.
1918	2,385,361	6 137,283	51s. 5d.
1919	2,366,744	8 960.614	75s. 9d.
1920	2,312,436	12,289,602	106s. 3d.
1921	424,486	1,254,151	59s. 2d.

ALLUVIAL DIAMONDS

	Carats	Estimated Value	Value per carat
1913	206,049	£1,120,227	108s. 9d.
1914	143,924	576,729	80s. 2d.
1915	97,678	392,196	80s. 4d.
1916	167,620	948,571	113s. 2d.
1917	182,992	1,041,776	113s. 10d.
1918	143,438	964,574	134s. 6d.
1919	209,589	2,740,548	261s. 6d.
1920	221,460	2,441,440	220s. 6d.
1921	283,134	....	....

(From George F. Kunz in Mineral Industry).

In addition to the foregoing, the mines of the Belgian Kongo annually produce about 200,000 carats of diamonds; and something like 1,000,000 carats a year now come from South-west Africa (formerly German territory).

Imperfectly crystallized diamonds, unfit for gems, are called bort, and are useful in many branches of industry. The United States Department of Commerce classifies them, together with black diamonds, as "Glaziers', Engravers' and Miners' Diamonds." Bort is found in almost all diamond-producing districts, Brazil being one of the chief centers from which this country draws its supply, and in the past four years we have imported 121,868 carats valued at $3,472,507.

The only known source of black diamonds is Brazil. In former times, black diamonds were used almost exclusively in core drilling, exploration work with the so-called diamond drill. The high and rising price of these carbons, however, led to the introduction of the Calyx core drill, the diamondless drill that uses steel shot cutters in the periphery of the drill instead of diamonds. The diamond drill, however, is still largely employed, as it is peculiarly adapted to core drilling at an angle from the vertical.

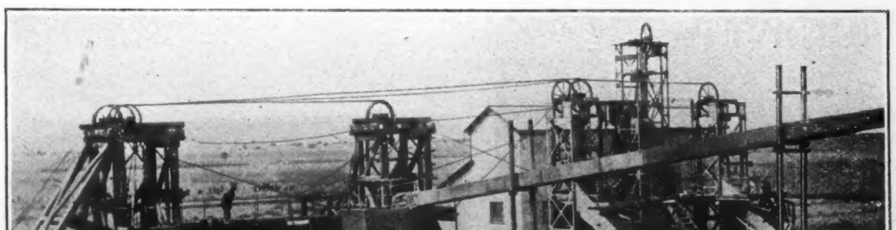
Industrial diamonds have a great variety of uses in the arts. Many tough, fibrous substances and insulating compounds, such as hard rubber, vulcanized fiber, celluloid papier-mâché, bakelite, cotton rolls, compositions of ivory, graphite, and mica, as well as alumnum and the harder bronze alloys, can scarcely be machined even with the best steel tools that rapidly lose their cutting powers because of overheating. With diamond tools, however, no trouble is experienced in quickly and accurately finishing to the finest micrometer measurements. The turning of hard-rubber fountain pens, that involves the most accurate fitting, is done without difficulty with diamond-pointed tools. High cutting speed can be maintained; and a single diamond has been known to cut, without regrinding, over 100,000 pieces.

© Brown Bros.

Here operatives are seen carefully looking for diamonds in the gravel washed from the blue ground.

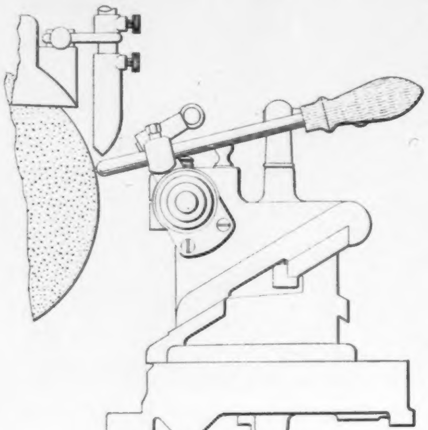
Another operation well performed with the diamond is the turning or truing of "felt" rolls used in paper mills. These rolls are about eight feet long by fourteen inches in diameter, and are built up of a number of discs of tough paper mounted on a spindle under heavy pressure. Upon this hard, fibrous substance the steel tool hardly makes an impression, while a diamond point quickly and accurately gives the entire surface a smooth finish resembling that of polished wood.

Diamond-pointed tools are used in finishing the hard-rubber parts of water meters, bronze bushings, valve discs and seats, and commutator bearings, as well as for the internal grinding of cylinders and heavier borings of bronze, aluminum, and copper. The diamond is also invaluable in the cutting of glass. The need of the diamond in industry for cutting tough, hard materials has brought into use many tools especially designed to do this work. Among these may be found pneumatically adjusted micrometer tools for cutting glass and other substances, special glaziers' tools with intricate attachments for maintaining the accuracy of the cut, etc., etc.



One of the numerous workings in South Africa of the DeBeers Consolidated Mines Company, Ltd., the biggest diamond mining company in the world.

The diamond industry, as a whole, suffered materially in the recent depression that affected all industry. Many of the big South African mines were closed down in 1921, and more or less gloom prevailed. One of the chief contributing causes was the unloading of enormous quantities of gems on the market by the impoverished nobility and aristocracy of Central Europe and Russia. This condition was

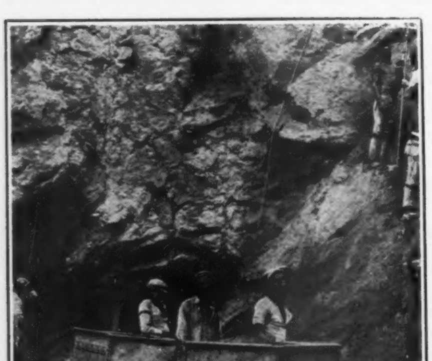


Courtesy Brown & Sharpe Mfg. Co.

Diagram illustrating manner in which a diamond tool is held in position while truing a grinding wheel.

accentuated by the fact that many Americans had bought diamonds during the recent "boom" times and, finding themselves unable to carry them, put them back on the market.

It is the concensus of opinion in the trade, however, that the market has now almost adjusted itself—an operation that has been brought about much sooner than if the dia-



© Underwood & Underwood.

Natives at work in one of the galleries of a DeBeers diamond mine in South Africa.

monds to be absorbed had been new productions from the mines instead of old gems. Although prices are rising, keen observers do not look for a return to normalcy in diamonds as gems until the world's trade is again flowing in the well-balanced, pre-war channels. But in the market for industrial diamonds the recovery is expected to be more rapid.

SAFE COAL STORAGE TO STABILIZE THE INDUSTRY

THE SAFE storage of bituminous coal is probably the only solution of the problem of stabilizing the coal industry—at least, such is the conclusion of certain investigators of the United States Bureau of Mines and the Carnegie Institute of Technology, who have but lately completed a study of the spontaneous combustion of soft coal.

These experts state that as long as the peaks of demand react upon the miners, the coal industry will necessarily be a seasonal one, and this will occasion an unsatisfactory labor situation. As these technicists sum up the situation: "If some system could be devised whereby coal can be stored economically, with little deterioration and danger of spontaneous combustion, the mines might be operated practically the whole year—say, 300 working days instead of 180 to 270 days, as in 1920—at a uniform rate of production. Unfortunately, no such general storage system has yet been devised."

However, the investigators have gone to some trouble to weigh the various factors bearing upon this topic of nation-wide interest, and they have even suggested a procedure which may possibly play a very helpful part in making it practicable to store bituminous coal safely for considerable periods. The following résumé of their work is, therefore, a timely contribution to knowledge which sooner or later may benefit all of us.

The loss by deterioration of coal at ordinary temperatures is small when compared with that caused by rapid oxidation at elevated temperatures and by spontaneous ignition. To overcome the hazards of self-heating and spontaneous combustion, various means of storage have been suggested, such as storing under water or in an atmosphere of carbon dioxide; screening the coal and storing only large sizes; cooling the coal pile by means of ventilating pipes; covering the coal pile with sand or with a layer of fine coal to prevent breathing of the heap, etc. Many of these methods do more harm than good, and others are prohibitive on account of their cost.

The tendency of coals to fire spontaneously differs with their age—the younger coals being the most dangerous. No case has been recorded in which anthracite, even fines and slack, fired spontaneously. On the other hand, lignite can not be stored even in lumps with safety, except under water. Between these two extremes are the various grades of bituminous coals, the class most commonly stored. The liability of different bituminous coals to fire varies; but, broadly speaking, the bituminous coals of the eastern part of the United States store better than those of the Middle West. These, in turn, are safer to store than the sub-bituminous coals of the intermountain region. The classification as to self-heating coincides with the classification of coals, beginning with lignite as the most dangerous, ranging through sub-bituminous, bituminous, semi-bituminous, and anthracite as the least prone to spontaneous combustion.

The solution of the problem of spontaneous combustion may lie in the microscopic examination of coals and its correlation with the rate of heating. Coal is composed of three parts, namely, anthraxylon or bright coal, attritus or dull coal, and mineral charcoal; and may be separated into almost pure samples of each. Tests indicate that the anthraxylon is the constituent that heats first in the spontaneous heating of coal.

As the results of the experiments it is stated that the presence of fines in a coal pile should be avoided. Coal should be handled as little as possible and should be screened wherever practicable before storing. Coal coarser than ¼ inch showed no rapid self-heating throughout the experiments. Wetting the coal pile to retard heating is not good practice unless the coal is completely immersed, as moist air will give a lower "critical" or spontaneous combustion temperature than dry air.

Instead of hastening spontaneous combustion, partly oxidized coal, when mixed with fresh coal, seems to act as a deterrent. The danger in mixing two grades of coal, or in storing coal on the same pile at different times, arises from physical rather than chemical causes. If no heating has occurred at the surface of the heap it is safe to pile more coal on top, provided there is no accumulation of fines at the contact of the new and old coal. A mixture of two kinds of coal will heat more rapidly than the poorer of the two. Artificial mixtures of coal and pyrite in various proportions showed a critical temperature no lower than that of the coal alone, while pure pyrite had a critical temperature 26° C. higher than the coal. From this it appears that massive pyrite or "brass lumps" are not dangerous in a coal pile.

On account of the low conductivity of coal, cooling by artificial ventilation is almost impossible unless the air reaches every part of the pile. Exclusion of air, in order to stop oxidation, is more successful than attempts at ventilation to dissipate the heat.

Coals, under various physical and chemical conditions, have been tested to determine the temperature at which they generate heat so rapidly that, provided no deterrent is applied, the coal will eventually ignite. This temperature has been arbitrarily called the "critical temperature;" and this method of testing coal may be applied to the various coals of the country for grading their relative tendencies to fire spontaneously.

ANCIENT COPPER PIPE

THERE has come to New York from Egypt a piece of copper pipe said to be about 5,400 years old. The piece is 3½ feet long and 3½ inches in diameter, and was cut from a pipe found in excavations at Ghizeh, near the tomb of King Sahoure. The pipe, under its green incrustation, is still in good metallic condition, and may be bent freely. The specimen was obtained by the Copper & Brass Research Association from William Coffin, American Consul General at Berlin, Germany.

Calking the 48-inch gas main with lead wool which is driven into place with pneumatic hammers. There are seven calking gangs on the job.

The two portable air compressors that were moved along beside the trench and supplied power for the calking tools.

Showing strands of wool yarn being packed into the joint with the pneumatic hammer.

LAYING A BIG HIGH-PRESSURE GAS MAIN

By C. W. MELCHER

TO TAKE care of the increased output of gas from the coke ovens and the water-gas equipment of the big by-product plant at 35th Street and Crawford Avenue, Chicago, the Peoples Gas Light & Coke Company recently finished the installation of distribution mains of unusual size and length.

With the completion of this large plant and the 10,000,000-cubic-foot gas holder, in the spring of 1921, a future increase in gas-distribution requirements was anticipated by the construction of a concrete tunnel, 1,700 feet long, extending south from the big holder and passing under the Chicago Drainage Canal, the Illinois & Michigan Canal, and the Atchison, Topeka & Santa Fe and the Chicago & Alton railroad tracks. This tunnel housed a 48-inch connection from the gas holder to 39th Street and Crawford Avenue; and from this point on the plans provided for a 48-inch main which would take care of the needs of the south and the southwest sides of Chicago for some years to come.

The work on this big pipe line, which was started May 15, 1922, at 71st Street and Hamlin Avenue, the southern terminus, was pushed continuously to its junction with the Crawford Avenue tunnel, a distance of 4½ miles. On October 14, the last piece of 48-inch pipe was put in, and gas was turned into the main the following day—an average progress of about 180 feet per day, or, for the days actually worked, an average of about 200 feet per diem.

While the excavating of the trench and the laying of the pipe were done by contract, the gas company employed its own men for the calking and the testing of the pipe line. The 7x7-foot trench, in clay soil, entailing the excavation of about two cubic yards per linear foot, was dug with ease by the largest size Austin excavator; and each pipe section, weighing about four tons, was placed in position by a 10-ton gasoline crane on a caterpillar tractor of the type made by the Northwestern Manufacturing Company.

Speed of execution as well as economy were outstanding features of this work; and previous experience in the laying of smaller mains had demonstrated that air-calked, lead-wool joints could be finished in half the time and at half the labor cost of hand-calked joints. With these facts in mind, pneumatic equipment was chosen; and the company installed three Ingersoll-Rand portable, gas-driven air compressors, each having a capacity of 210 cubic feet of free air per minute at 100 pounds gage pressure. Likewise, 40 "Little David" pneumatic calking hammers were provided for the job.

In carrying out the work, an air-line header was always kept two city blocks in advance of the calkers, and T-connections were made at regular intervals to supply air to the tools. Two compressors were regularly linked up with the air line, thus leaving a third machine in reserve to move on to the next station. In this way a continuous service was maintained with the two compressors; and from ten to fifteen 2-men gangs of calkers were kept on the

job—each man operating a calking tool. Each "Little David" was good for an average of one joint per 8-hour day; but several gangs were so expert that by working about half an hour overtime they were able to calk three full joints per day, or $1\frac{1}{2}$ joints per man. The joints to be filled were $\frac{5}{8}$-inch thick by five inches in depth, and had a circumferential length of thirteen feet. Each was first filled and calked with wool yarn to a depth of three inches, and then two inches of lead wool completed the job—every joint calling for eight pounds of wool yarn and 126 pounds of lead wool. The entire undertaking required about 125 tons of lead wool.

Every Saturday, at noon, with all the joints calked, the traction crane lowered the 48-inch plug to close the end of the last pipe, and then the three air compressors were hooked up to the line and the big main was tested out, as far as it was laid, under fifteen pounds air pressure.

At the pumping station, where the gas is made, it goes to a booster and from there is pumped into the 48-inch main, which has a maximum capacity of 3,000,000 cubic feet of gas per hour; and with an initial pressure of six pounds and a 1-pound drop at 71st Street and Hamlin Avenue, nearly five miles away, there will pass through the main approximately 1,500,000 cubic feet of gas per hour.

Compressed air was used in a novel way in cutting off the final section of 48-inch pipe to make the closing length for the big main. This work previously had always been done by sledge and hand dolly, but with the air-calking equipment available the pipe was cut by two "Little David" hammers which went twice around it with the diamond point and then with the chisel point. No sledging was done until the $1\frac{1}{4}$-inch thickness of cast iron was completely cracked through. This part of the work was accomplished in less than half the time necessary to do it by hand.

The writer wishes to acknowledge the courtesy of Mr. F. S. Carnes, Superintendent of the Southern Division of the Peoples Gas Light & Coke Company, who very kindly furnished the data needed for this article.

GASOLINE FROM COAL

Dr. Friedrich Bergius, in a recent report to the Birmingham University Mining Society, has announced that he has discovered a process for the production of gasoline from coal. Experiments made at Mannheim, Germany, where a plant with a capacity of 60 tons per day has been installed, have been successful.

It is said that the conversion of coal into petroleum is achieved by introducing hydrogen, which completely changes the chemical character of the coal and reduces about 90 per cent. of it into a liquid much like fuel oil. This oil, by another process, is then transformed into light oils and gasoline, the latter totaling about 40 per cent. of the volume of the fuel oil treated. There is left an equal percentage of Diesel engine oil.

From ancient records we learn that glass of a superior quality was manufactured in India centuries before the present era.

NEW AIR BRAKE FOR FIRE FIGHTING APPARATUS

THE Westinghouse Company has developed an air brake for heavy fire apparatus, and a successful trial of it was made recently, at Pittsburgh, Pa., upon an 11-ton American-La France tractor-drawn aerial truck.

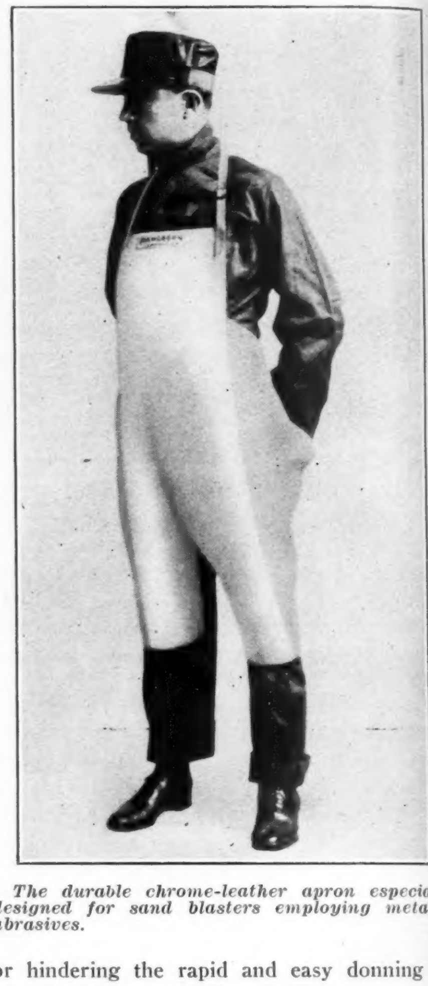
Instead of depending on the muscular force in the foot of the operator, the brakes are set by the compressed air acting on pistons connected with the brake-rod; and their action is controlled by the lever of an air valve, giving quick and effective brake control when the machine is traveling at high speed. The foot and the hand brakes are retained as additional safeguards, and their action is not interfered with.

NEW SAND-BLASTING DRESS

THE SUBSTITUTION of steel shot and grit for sand as an abrasive medium in sand blasting, is steadily growing in favor among foundrymen. There is a good reason for this preference. The metallic abrasives have substantially two and a half times the specific gravity of sand, and, accordingly, their striking force is proportionately increased. Further, the new abrasives do not disintegrate as is commonly the case with sand.

However, the adoption of steel shot and grit introduces a factor that must be taken into account. That is to say, the rebound of the metallic abrasives is more wearing on an operator's hood and clothing, and this has necessitated the development of improved garments for the work. To meet this demand, the Pangborn Corporation has lately placed on the market what is styled a "Shotpruf" apron and hood.

The front of the apron is made of chrome leather and is capable of fully protecting the operator's clothing. The apron is securely held to the worker's legs by means of spring clips, and yet this is effected without binding the legs or hindering the rapid and easy donning or removal of the protective garment.



The durable chrome-leather apron especially designed for sand blasters employing metallic abrasives.

The hood also has a chrome-leather front and crown, and this material is far better able to resist wear than any fabric. A finely woven, extra-heavy wire sight screen, which can be readily and cheaply replaced, protects the operator's eyes while insuring clear vision. The hood has an adjustable band so that it can be made to fit a head of any size.

The hood of the new sand-blasting dress, closed and open.

Fine Showing of Liquid-Oxygen Explosives in Silver Mines

The Results Obtained with the New Blasting Agent in Mexico are of Outstanding Significance to Many Branches of Industry

By ROBERT G. SKERRETT

LIQUID-OXYGEN explosives have been successfully employed for the first time on a commercial scale in the Western Hemisphere at two mines of the Real del Monte Company, Pachuca, Mexico. A paper, comprehensively covering this innovation and prepared by Michael H. Kuryla and Galen H. Clevenger, was read recently before the American Institute of Mining & Metallurgical Engineers. The following article is based on the foregoing paper and deals in the main with the actual applications of the novel explosive rather than with the apparatus employed to provide the needful liquid oxygen.

It might be well, however, to emphasize at the very start that the success of modern liquid-oxygen explosives is principally contingent upon the employment of oxygen of a high degree of purity. The performances obtained at Pachuca were the result of the use of liquid oxygen of from 94 to 95 per cent. purity, and the cartridges were, therefore, not saturated with liquid air, as was the case when pioneer tests were made in 1899 during the driving of the northern end of the Simplon Tunnel. This phase of the subject has been dwelt upon in the contribution on liquid-oxygen explosives which appeared in the preceding issue of this Magazine.

It is rather interesting to recall that the introduction of liquid-oxygen explosives in Mexico was really inspired by a desire to find a way to utilize a possible secondary product. It seems that early in 1919 the technicists of the Real del Monte Company had under consideration a process in which it was thought a large volume of gaseous nitrogen might be required; and, in looking about for directions in which the by-product oxygen could be put to service, the European use of liquid-oxygen explosives —known, briefly, as L. O. X.—offered a solution of the problem. Accordingly, a liquid-oxygen plant, then in Mexico, was acquired. This equipment was installed at Pachuca, and was put in operation during August, 1921. It has proved capable of producing at that altitude, 8,000 feet above sea level, a matter of 25 liters, that is 60.6 pounds, of liquid oxygen hourly. This measure of liquid oxygen has been sufficient to permit the extensive use of the new explosives in the two silver mines concerned; and it is probably not over-stating the case to say that the engineers in charge are fully convinced of the merits of liquid-oxygen explosives.

Messrs. Kuryla and Clevenger have brought out an aspect of the subject which answers at once a question likely to arise in the mind of every practical mine operator. The attitude of miners towards liquid-oxygen explosives and the training period required to make the men proficient in their use are matters vitally affecting the adoption of L. O. X. in place of the usual blasting agents. The authors have cleared away any doubt by the following statement: "When this investigation was initiated, it was feared that the miners would be prejudiced against the use of a new explosive and, at best, that a rather long training period would be required before they could use it effectively. Fortunately, these difficulties, which would have seriously interfered with a prompt appraisal of the value of L. O. X., were only imaginary; the miners accepted the innovation enthusiastically and their training proved to be a simple matter." Not only was no great difficulty encountered in training Mexican workmen to manufacture L. O. X., but the miners, so we are told, came, in a short while, to "prefer it to dynamite."

A close-up of liquefier and rectifying still. Filling a transport container with liquid oxygen.

As has been explained in our March issue, the liquid oxygen must be combined, by absorption, with a carbonaceous material in order to provide a suitably powerful explosive; and the success or failure of the explosive is dependent, to a considerable degree, upon the kind and the condition of the carbon used. It must be understood that the carbonaceous matter comprises both the paper wrapper or cartridge shell and the absorbent material with which the cartridge is charged. Therefore, care must be exercised in selecting the paper—preference being for a kind sufficiently porous to absorb enough oxygen to insure well-nigh instantaneous and complete combustion of the wrapper. Messrs. Kuryla and Clevenger have thus enumerated the characteristics which a satisfactory wrapper should possess: It should be inexpensive; it should be readily penetrated by the liquid oxygen; it should be sufficiently strong, both before and after soaking in liquid oxygen, to withstand any ordinary and even rough handling that the cartridge may receive; and it should be a good heat insulator, so as to increase the available life of the cartridge.

After considerable experimenting, the wrapper finally adopted for regular use is made of a Kraft wrapping paper weighing 45 pounds per ream of 500 sheets. This paper is manufactured from partly refined pine fiber in which remains some of the resin. This, together with the sizing of resin soap which is employed in the finishing, produces a paper that is somewhat resistant to water—a quality desirable in the wrapper of a liquid-oxygen explosive. The paper absorbs liquid oxygen satisfactorily, has good insulating properties, is strong, easily handled, and relatively inexpensive.

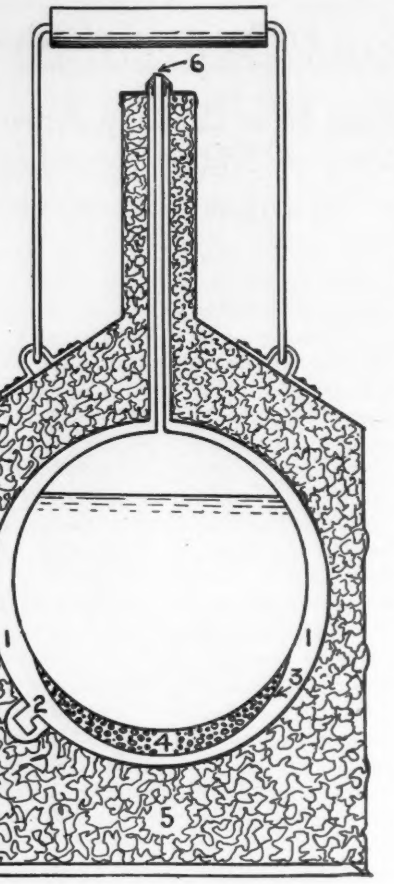
One ream will make 6,000 wrappers or cartridge shells each 1.1 inches in diameter and twelve inches long, or 4,500 wrappers for cartridges 1.38 inches in diameter and twelve inches long. The cartridge shells are formed by rolling a sheet of paper twice around a wooden cylinder of the prescribed dimensions, and the work is completed by securing the outer edge with starch paste. A ream of the paper, delivered at Pachuca, costs about $6 in United States currency; and a boy, who is paid 75 cents for a working shift of eight hours, can make 1,000 wrappers in that time. Tests conducted with cartridges fashioned of one, of

About to pour liquid oxygen from the transport container into the cartridge dipping vessel.

two, and of three layers of Kraft paper revealed that there was a marked difference in the performance of each. The purpose of these researches was to secure the longest "available life" practicable after removal of the cartridges from the soaking cans.

For the sake of those unfamiliar with this whole subject, let it be said that the authorities we are now quoting state that: "The 'life' of the cartridge is the period of time, expressed in minutes, that elapses from the time the cartridge is removed from the dipping container until it ceases to be explosive. . . . The 'available life' is the period of time, expressed in minutes, which elapses from the time the cartridge is removed from the dipping container until the point is reached where there is the proper proportion of oxygen to give complete combustion of the active absorbents and the paper of the wrapper. The available life, which is the important consideration, is influenced by the nature of both the absorbent and the wrapper, and the conditions under which its determination is made. . . . The available life in a drill hole is generally from two to three minutes longer than that indicated by a determination made in the open air." When a round is loaded and fired within an interval of ten minutes the shattering effect of the L. O. X. is generally satisfactory.

Recent experiments at Pachuca, so it is declared, indicate that the available life of the cartridge can be increased about 40 per cent. over the double-wrapper cartridge previously used by forming the shell of a single wrapper and, then, after removing the cartridge from the liquid oxygen, by slipping over it a single dry wrapper. This procedure requires no more paper than the double wrapper of which, in effect, it is only a modification. The double wrapper, per se, is objectionable because of the increased amount of liquid oxygen needful to saturate it in the first place; the time required to effect saturation; and the rapidity with which the oxygen evaporates before the cartridge can be fired. In the latter case there is not enough oxygen available to properly consume all the carbon content of the paper, and there is produced, in consequence, noxious carbon monoxide instead of harmless CO_2.



Cross-sectional view showing general characteristics of the type of container used to carry liquid oxygen to the working face of a mine.

1. *Evacuated space surrounding the liquid-oxygen vessel.*
2. *Attachment by which the initial vacuum is produced.*
3. *Perforated plating.*
4. *Granular charcoal.*
5. *Insulating material.*
6. *Vent for the escape of vaporizing liquid oxygen.*

In the earlier days of the use of L. O. X. at Pachuca, the cartridges were loaded with a carbon-black absorbent obtained from Europe. While this stuff met every requirement, so far as its explosive action was concerned, it was objectionable by reason of what it cost delivered at the mines in Mexico. Carbon black, commonly known as lampblack, is bulky for its weight, and, therefore, subject to high transportation charges. Before the imported carbon black was exhausted, efforts were made at Pachuca to secure a cheaper, local substitute. In this quest a number of substances were given practical trials. The results are thus briefly summarized by Messrs. Kuryla and Clevenger:

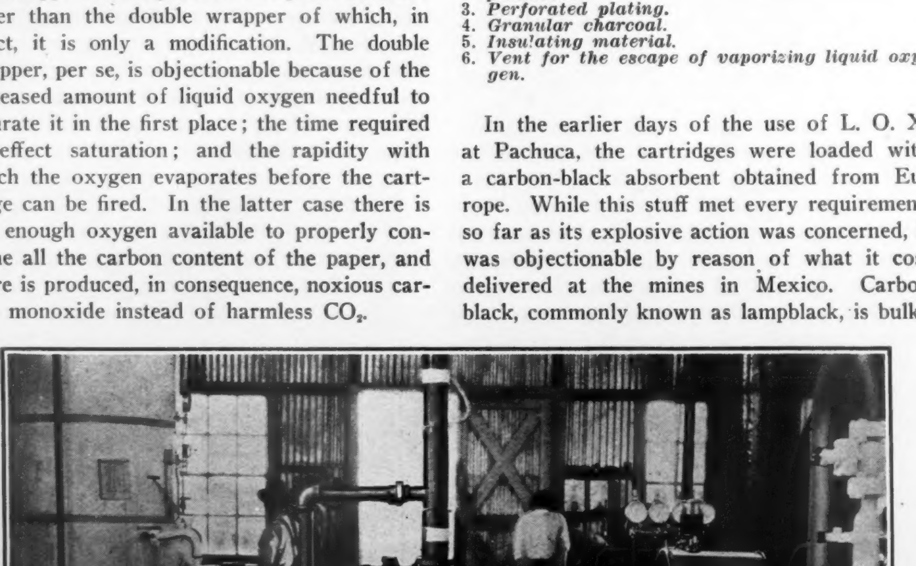
"Sawdusts and pulps of various woods as well as the residue or bagasse from *guayule* (Mexican rubber shrub) showed a fair absorption and 'available life' and were inexpensive, but the breaking effect in the mine was poor or the cartridge failed to detonate. Kerosene, gas oil, and fuel oil were added to secure greater explosive strength, but these reduced the available life to a point that was too low. Cotton, cotton waste, and *kapok* (a native tree cotton) showed high absorption, but the explosive strength was low, the cartridge difficult to fill, and the cost excessive. When oils were added, there was too great a decrease in the available life. Pulverized wood charcoals, bituminous coal, and coke gave very low available life. Admixture of kieselguhr with these increased the available life, but the strength was too low."

Wherever L. O. X. is utilized in the regular mining operations at Pachuca, the present practice is to use but a single absorbent, that is, carbon black. This is now made by natives from Mexican fuel oil (*chapopote*), by a rather crude process, at several primitive plants in the neighborhood of Mexico City. The procedure, so we are told, consists in allowing the oil to fall drop by drop into pots, where it is burned in the presence of a deficient supply of air. The carbon black is extracted from the gases in connecting cement-lined masonry chambers; and about six pounds of oil are thus burned to produce one pound of carbon black.

The operation of loading the paper cartridges with the lampblack calls for comparatively little skill; and it has been found that native boys soon qualify for the job. It takes them but a short time to become proficient in producing uniformly filled cartridges of the correct density. This latter factor is one of great importance. If the cartridge be filled too compactly, there will be an excess of absorbent and the liquid oxygen taken up by it will be insufficient to effect complete combustion. On the other hand, if the paper cylinder be filled too loosely, then there will be a deficiency of absorbent, and the cartridge will be lacking in explosive power. With the simple loading equipment provided at Pachuca, a boy can fill as many as 1,500 cartridges in the course of an 8-hour shift. Using the Mexican carbon black just described, and filling them by hand, the cartridges before soaking cost, at the present time in equivalent American currency, as follows:

Size of cartridge	1.38x12 inches	1.1x12 inches
Weight of cartridge	0.14 pound	0.096 pound
Cost	1.85 cents	1.40 cents

There is reason to believe that the final cost of the cartridges could be decreased approximately 33 per cent. by installing a liquid-oxygen plant capable of producing 100 liters an hour. To effectually oxidize the carbon of the



A general view of the liquefying plant at Pachuca.

wrapper and the lampblack, so as to yield carbon dioxide, 2.66 parts of liquid oxygen must be available for each part of carbon. Allowing, therefore, for enough liquid oxygen to give a unit explosive effect equal to that of one pound of 40 per cent. gelatin dynamite, the total cost for the L. O. X., depending upon the size of the cartridge used, ranges at Pachuca from 9.19 cents to 9.50 cents. That is to say, to compete with this, 40 per cent. gelatin dynamite would have to be delivered at the mine for approximately 9.35 cents (United States currency) per pound to equal the direct costs now incurred with L. O. X. when relying upon what is recognized as an experimental plant for the production of the necessary liquid oxygen.

There are various other aspects of the work at Pachuca which we should like to cover if space were available, but, as it is, we are compelled to limit our review. The authors are fully alive to the fact that the employment of liquid-oxygen explosives is in a developmental stage, and that performances to date will undoubtedly be bettered as time goes on and more minds are directed to the advancement of the art.

We are informed by Messrs. Kuryla and Clevenger that, "The local practice with dynamite, in drifts and crosscuts, has been to load and fire the cut holes first; the same practice is followed with L. O. X. Two men load and fire eight 5.5-foot holes, requiring thirty-two 1.38x 12-inch L. O. X. cartridges, in about seven minutes. After waiting about five minutes for the face to clear, the two men are able to load and fire the remaining eight or ten holes in about eight minutes. When there are more holes in the last section of the round, say twelve to sixteen, a third man is required if the loading and the firing are to be completed within ten minutes. On several occasions twenty-two 5-foot holes, requiring 80 cartridges, have been loaded and fired at one time; employing two passers and two loaders and electric firing, the elapsed time was 9.5 minutes."

Finally, let us quote two more paragraphs from this informative technical contribution: "Our experience may be of interest to others who may contemplate introducing L. O. X. The miners, who are not concerned with the cost of the explosive used, invariably prefer L. O. X. The contractors, when it can be had at the same cost as dynamite, likewise prefer to use it. One reason for this preference, notwithstanding the extra trouble of handling the necessary paraphernalia, the necessity for haste in loading and firing, the limitation on the size of the round, and the inability to load holes in advance to be shot later at a predetermined time, is that the comparative freedom from noxious gases permits them to return to the face promptly, in most cases within five minutes after blasting; this, they feel, is a decided advantage. Undoubtedly, the greater safety of L. O. X. has a considerable influence upon their preference. When a misfire occurs, they can remove the dead cartridge promptly and reload the hole; the danger of drilling into missed holes is practically eliminated. There can be no dangerous explosive in the waste pile. Another important point is that, in general, there is more of a shattering effect

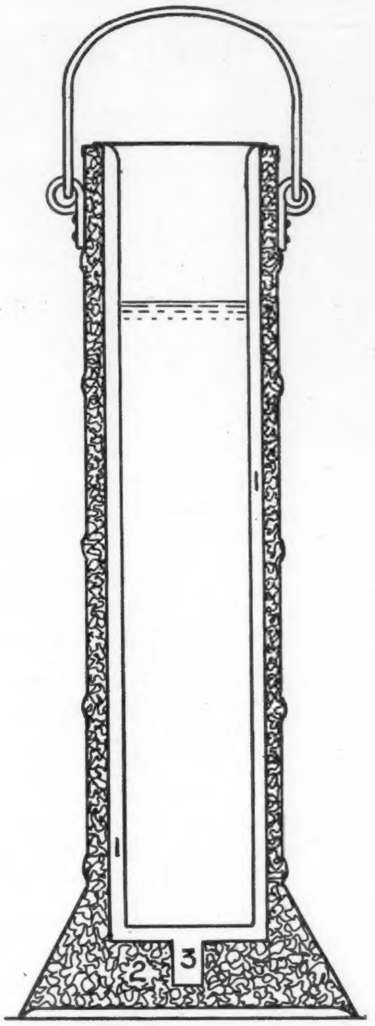


Diagram illustrating the type of vessel in which the cartridges are dipped and saturated with liquid oxygen.
1. *Evacuated space immediately surrounding the liquid-oxygen carrier.*
2. *Space filled with insulating material.*
3. *Connection for vacuum pump.*

which tends to break the rock smaller, thereby reducing the work of bulldozing. The prompt acceptance of the new explosive is all the more noteworthy in a locality where the theft of dynamite reaches considerable proportions; so far as we know there has been no stealing of L. O. X.

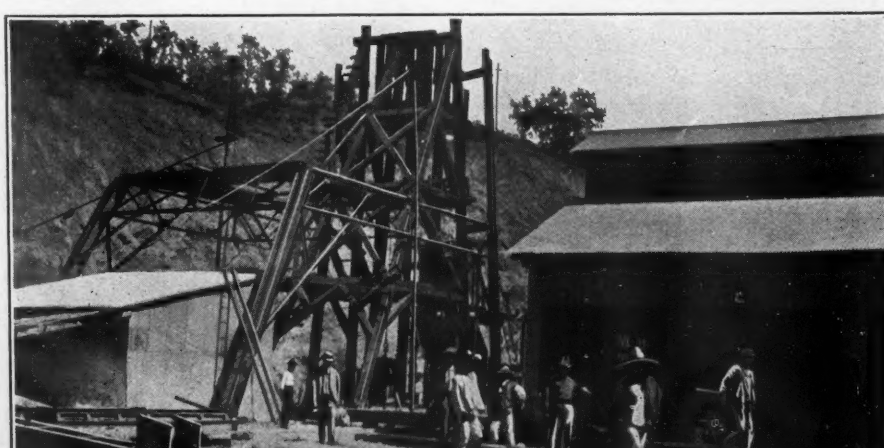
"The time necessary to introduce L. O. X. into a working mine, employing native miners and under the conditions obtaining at Pachuca, is illustrated by the experience at the Rosario mine. This mine is worked through a tunnel and two interior shafts. The monthly development advance amounts to about 400 feet, and stoping is done on two levels. The average production per day of two shifts is 475 metric tons. The new explosive was first used on January 9, 1922, and by the end of the month approximately 90 per cent. of all the blasting in the mine for both development and stoping was being done with L. O. X. It was found that the native miners, after observing the loading of two or three rounds, were able to use this explosive quite effectively."

AZTEC RUIN INTERESTING NATIONAL MONUMENT

THE remarkable Aztec ruin near the town of Aztec, New Mexico, was established a national monument recently by proclamation of President Harding and placed under the jurisdiction of the National Park Service. This prehistoric ruin is of the well-known pueblo type—a large E-shaped structure of approximately 500 rooms.

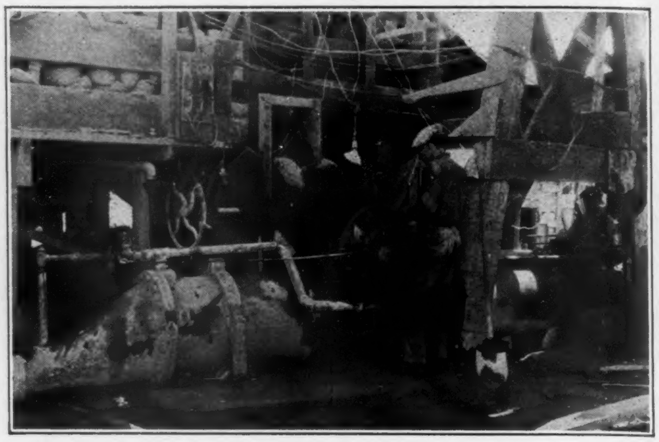
The first story is still standing, and 24 rooms are complete in that the original ceilings are intact. Many of the second-story rooms and some above that are in an excellent state of preservation. The walls, which are reasonably plumb, are of dressed sandstone; and as an example of prehistoric masonry they rank high. The large beams, which support the ceilings, were cut and dressed with stone tools, and are a striking exhibit of the skill with which they were chiseled by the people of that remote Stone Age.

At the Modder Fontein Government Gold Mining Areas in Cape Colony, a great circular shaft is being sunk entirely for ventilating purposes. It is 22 feet in diameter, and will go to a depth of 3,500 feet. It is being lined with steel tubing, and is to be supported by concrete. A fan is to be installed having a capacity of 1,000,000 cubic feet of air per minute.



At the shaft of one of the Pachuca silver mines where liquid-oxygen explosives are used.

A general view of Pit River Power Plant No. 1. The great steel penstocks, carried up the mountainside, link the tunnel running to Fall River with the turbo-generators in the power house 454 feet below.



The concrete gun used on the Pit River project. Immediately back of the gun is seen the concrete mixer which dumps a charge into the gun just before compressed air is turned into the latter to drive the concrete to the point of placing.

COMPLETION OF PIT RIVER POWER PLANT NO. 1

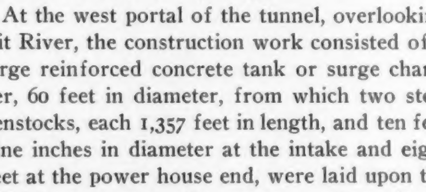
DURING THE latter part of 1922, to be exact on September 30, the waters of Fall River were diverted through a tunnel and dropped 454 feet through steel penstocks to the Pit River Power Plant No. 1 of the Pacific Gas & Electric Company. From the tremendous force of this falling water there is now being developed 93,000 H. P., which is available for use in factories, on farms, and in homes in the State of California.

When the two 46,500-H. P. electric generators of the plant began to function, they signaled the completion of the first big unit of power development along the Pit River for which $100,000,000 will ultimately be expended by the company in question. California is now the greatest hydro-electric power state in the Union—over one-fifth of all the electric power generated in this country by water is produced there. Compressed air is used extensively both in the construction and in the operation of all the hydro-electric plants of California.

In the construction of the Pit River Power Plant No. 1, the transformer handling house was built as a part of the power plant. There are seven transformers, placed out doors under the switch structure, which step up the current from 127,000 volts to 220,000 volts—the world's highest voltage. A track parallels these transformers, and a special steel truck has been provided for transporting them to the transformer handling house and back again. By this means the 80-ton transformers can easily be moved to the transformer house for repairs and overhauling. A short time ago, each of the seven transformers was taken into the house, where the cores were removed, inspected, assembled, and dried by compressed air. For this purpose there is provided a portable apparatus consisting of an air compressor and grids for heating the air. This heated air was blown through the coils, which were thus dried out in three weeks. The Pacific Gas & Electric Company has about twenty such portable outfits in use throughout its system.

The Pit River project involved, among other engineering features, the construction of a diversion dam across Fall River—a concrete structure 500 feet in length, and an intake canal, 1,000 feet long having a capacity of 1,800 cubic feet per second, which serves to carry the water to the east portal of a tunnel that is 10,160 feet long, fourteen feet three inches high, about thirteen feet wide at the line where arch and sidewalls meet, and eleven feet wide at the base. The lining for this tunnel was placed by a concrete gun mounted, together with a concrete mixer, on a truck with flanged wheels running on steel rails laid on the tunnel floor.

At the west portal of the tunnel, overlooking Pit River, the construction work consisted of a large reinforced concrete tank or surge chamber, 60 feet in diameter, from which two steel penstocks, each 1,357 feet in length, and ten feet nine inches in diameter at the intake and eight feet at the power house end, were laid upon the hillside to convey the water to the wheels. These penstocks were riveted together with pneumatic hammers, air for which was supplied by a compressor located near the power plant and piped the entire length of the penstocks. The penstocks were laid above ground on concrete piers securely held by anchors.



Looking into the tunnel, showing a section with wooden forms and reinforcing steel bars in position preparatory to receiving the lining coat of concrete.

Two concrete tunnels, having an inside diameter of fifteen feet and a length of 185 feet, were constructed under the switch house and extended from the generating machinery in the power house to the foot of the slope. The penstocks were connected underground with the power house by means of these tunnels.

The power house is five stories in height, built of reinforced concrete and heavy structural steel, 137 feet long, 45 feet wide, and has a front elevation of 67 feet. The switching apparatus is located in a rear wing, which is 105 feet long by 31 feet wide. Considerable architectural skill has been shown in the design of the power house, which is Gothic in character. The excavation for this plant and the tailrace leading to the river required a cut of about 1,200 feet in length, and this was lined with concrete to a point above the water level and then filled in with rubble.

BIG HARBOR DEVELOPMENT AT RIO DE JANEIRO

EXTENSIVE and highly interesting engineering operations are planned for the harbor of Rio de Janeiro, Brazil, and Vickers, Limited, so we learn from *Engineering,* has under construction the necessary plant for the underwater operations. It consists of three units, each of which is composed of two floating pontoons and an underwater working chamber.

Two caissons are in the form of diving bells, in which air pressure is maintained to exclude the water, and are to be used for operations at greater depths. A third working chamber is in the form of a cofferdam, from which the water can be pumped, and provides a space in which the work commenced in the air caissons can be continued under atmospheric conditions.

Each of these caissons and cofferdams is suspended and operated from two floating pontoons trussed and braced together. The raising and the lowering of the suspended structures are done by means of hydraulic jacks; and the pontoons will contain electric cranes, concrete mixing apparatus, and the necessary power plant for the work.

Drill Steel and the Drill Steel Sharpener

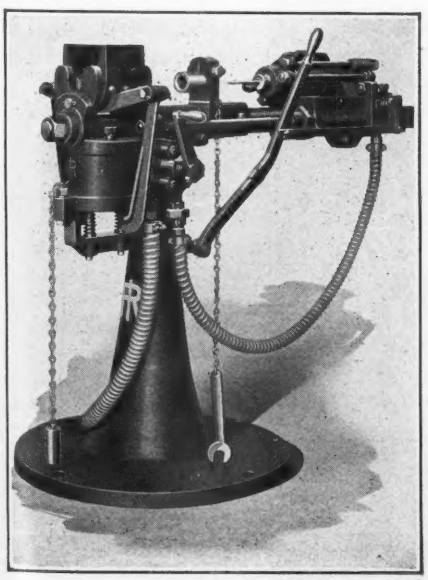
PART III

By FRANK BLACKWELL

HAVING POINTED out why good bits are well worth while and poor ones a continual vexation and source of loss, now let us take up the study of the hammer drill and its manner of working.

The modern hammer drill, which within the last few years has come into general use and is now the recognized standard, still requires much study to reach the zenith of efficiency. Although much is already known about it, and a great deal of time has been spent in the development of its operating possibilities, there still remains need of an educational campaign. It is the purpose of this article to go into each phase of the rock-drill machine and to endeavor to point out definitely the whys and wherefores of the hammer drill. In the first place, we must know what a modern hammer drill is and become more familiar with its internal mechanism.

In working on the hammer drill, Mr. J. George Leyner, the pioneer in the hammer-drill field, determined that the hand-hammer blow was the most efficient method of applying power to the cutting edge of a drill steel. By this method the entire energy of the blow is delivered through the drill steel to the cutting face of the rock. With the old reciprocating type of machine much energy was lost in moving the drill steel forward and backward. Friction was also caused by pushing the steel through cuttings. In other words, with the hammer drill the energy of the blow is applied in cutting rock and is not lost in overcoming friction and inertia. The hammer drill delivers mechanically the equivalent of an efficient hammer blow, but at the rate of from 1,200 to 2,200 blows per minute, depending upon the make, the size, and the type of drill.



Pneumatic shank and bit punch, pedestal pattern. This is a hollow drill steel punching machine, and is an essential part of the outfit of any sharpening shop that has to take care of numerous drills. Note the pneumatic vice for holding drill steel.

The machine consists of a freely moving hammer which strikes upon the end of a loosely held drill steel. The hammer is controlled by a valve or by an arrangement of ports, as in the valveless type of drill. Manufacturers recognize the efficiency of this hand-hammer blow and make use of it in all up-to-date machines.

The modern hammer drill is built either with a valve or a valveless mechanism. Both types, as constructed, are very good, and each lays claim to distinctive advantages. The valveless mechanism is one in which the valve and the piston features are incorporated in a single unit. The piston acts as the valve, and controls its reciprocating motion by covering and uncovering its own ports. The valves used are of the air-thrown or balanced type, thrown by compression of air at either end of the piston stroke. The piston on approaching either end of the cylinder necessarily drives some air, which acts as an air cushion, ahead of it and prevents the piston from striking against the end of the cylinder. In all drills a space is left between the front port and the front of the cylinder to provide for the cushion. In doing this, the pressure of air in that section is increased over the line pressure, and the valve is thus thrown for the return stroke. There is another valve in use now which does not, however, control admission or exhaust of air but relieves back pressure so that the full blow of the piston will be used for cutting rock.

The rotating mediums employed at present are essentially of two kinds—pawl-and-ratchet, and turbine. The pawl-and-ratchet type is of two sorts—ratchet in the rear and ratchet in the front end of the machine. The rotating motion is under the control of the piston travel. The rifle-bar rotation, or ratchet in the rear, is one in which a rifled nut is placed in the rear end of the piston. The rifle bar contains pawls, which engage in a ratchet doweled in the extreme rear end of the cylinder. The flutes in the front end of the piston run into a proper nut in the rear of the chuck. The steel is loosely held in the chuck. The rotating motion is given by means of the travel of the piston, which turns in the rifling on the rifle bar, and by the piston working straight into the chuck. On the forward or hammer stroke the ratchet releases, and the piston strikes the steel unhampered by any rotating motion. The rotation, where the front end of the piston is rifled, operates on the same principle as that just referred to except that the body of the piston has straight grooves which work on ribs in the cylinder. The piston does not turn, but, instead, by means of the ratchet and pawls held in the chuck, rotates that part and the steel. The turbine rotation is one in which the rotating motion is given by a small, independent turbine connected to the chuck by means of reduction gears.

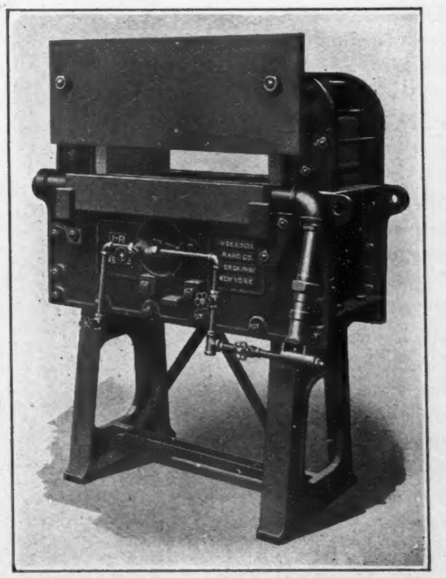
Water is carried through a tube in the machine into the drill steel. Mr. Leyner is responsible for this desirable feature, which has the three following advantages: Lays dust; cleans the hole of cuttings, which gives the steel a free rock surface upon which to cut, hence greater drilling speed; and keeps the drill bit cool—the bit can be used longer as wear is not so rapid.

The lug chuck is one so constructed that it takes round steel with a lug about one inch long by ⅜ inch high on two sides of the steel about three inches from the shank end. To insert the steel, the shank is run through the front end of the chuck and given a quarter turn. The lugs are engaged by shoulders in the chuck, and the steel is thus rotated but still not held tightly. With this type of chuck the piston strikes directly upon the end of the shank.

The anvil-block chuck takes hexagon steel, and no lugs are needed on the steel. The anvil block is a block of finely tempered steel which travels freely between the front chuck bushing and the chuck nut. The piston strikes the block which, in turn, strikes the steel. The advantages claimed for the anvil-block chuck are as follows:

1—No expense putting lugs on drill steel.

2—Less number of broken pistons, because the hammer end strikes on the broad, even surface of the anvil block instead of on the small cross-sectional area of the drill steel shank. The end of the anvil block next to the drill steel is worn cup shape from constant contact with the end of the drill steel and, in time, must be replaced. In the lug-chuck type previously referred to, the end of the piston is cupped where it comes in direct contact with the drill steel, and results in broken pistons.



Oil-burning furnace equipped with induction blower for cooling the steel and deflecting the flame. Also fitted with an improved burner which gives a satisfactory mixture at various air pressures.

It is much cheaper to replace an anvil block than a whole piston.

3—With the straight shank, as used in the anvil-block chuck, it is impossible to pull the drill steel from the hole by cranking the machine back under a full head of air, as the machine has no grip on the drill steel. This prevents the miner from trying to extract the steel, as he often does, with the lug shank. By eliminating this destructive practice the breakage of front end parts, side rods, and pistons is obviated. This saves drill parts.

"Jackhamers" in action at the bottom of an inclined shaft.

Hammer drills of wet or dry self-rotating and hand-rotated types are supplied. However, all hammer drills used in mining can be classified under three general heads, that is, drifters, sinkers, and stopers. Each type of drill is designed and built for the kind of work required of it; and the weight, the size, and the general exterior and interior are determined accordingly. Every manufacturer, however, bears in mind the fact that the weight must be consistent with the power of the machine, so as to insure a minimum of breakage which might result if parts are too light.

The heavy duty type of drill is generally mounted on a column by means of a cone, on the under part of the shell, which is clamped into a suitable saddle held on the column or arm. The general specifications of such a drill are approximately as follows:

Weight, 140 to 160 pounds; self rotating; screw feed; piston weight, 9 to 14 pounds; stroke, 2¾ to 3½ inches; bore, 2¾ to 3½ inches; piston speed, 800 to 1,500 blows per minute at 80 pounds air pressure; steel, 1 inch to 1⅜ inches. Steel generally used, 1-inch and 1⅛-inch hexagon or 1⅛-inch and 1¼-inch round. Water fed through drill steel or wet pattern.

Light drifters are usually of the "Jackhamer" type, mounted on a suitable shell and feed screw. The machine and the mounting weigh about 100 pounds, and the drill uses ⅞-inch hexagon steel with collar shanks.

Sinkers are generally known as "Jackhamers." Their trade names, however, are: "Jackhamer," "Clipper," "Rotator," etc. These handy tools are made in various weights and sizes, and are used for all classes of work. They are held by hand for drilling up, down, or flat holes where the ground is not too hard. All makes of this class are fitted with blowing devices with which to clean out the holes while drilling. One type, weighing about 100 pounds, with independent rotation, is obsolete. Sometimes the heavy drifters are taken from the shell and fitted with suitable handles. This is not common practice, however, as regular heavy-duty sinkers can be had. The general specifications of heavy and light sinkers, are approximately:

Heavy sinker—Bore, 2⅝ inches; stroke, 3 inches; weight, 70 pounds; wet or dry pattern; 1-inch hollow, hexagon steel "Jackhamer" shanks; self rotating. Light sinker—Bore, 2¼ to 2½ inches; stroke, 2 to 2¼ inches; weight, 38 to 45 pounds; wet or dry pattern; ⅞-inch hollow, hexagon steel "Jackhamer" shanks; self rotating.

There is one type of drill built along the general lines of the sinker which deserves special mention. It has practically the same general specifications except that the weight is about 35 pounds, and the drill is used with auger steel. It is generally employed for flat-hole work in the softer rocks and ores, but can be used effectively for very light sinking. More attention has been given to the rotating power than to the weight of the blow. In all operations, where the ground is soft and the cuttings are muddy or sticky, this machine works to best advantage. In some special cases it is mounted on an air-feed leg and used as a self-rotating stoper.

Stopers are utilized entirely for up-hole work, and are mounted on air-feed legs. They are of the self-rotating and the hand-rotated types. The general preference, at the present time, except under some special conditions, seems to be for the hand-rotated pattern. The anvil block is always used in these, because it serves, among other things, to keep cuttings, which run down the steel, from getting into the cylinder. The interior mechanism and working parts of the self-rotating stoper are essentially those of the drifter or sinker. In the hand-rotated type, because of the absence of the self-rotating feature, the piston travel is very fast—about 2,000 blows per minute. Also, the differential-piston-diameter feature, which adds to the efficiency of the blow, should be mentioned. The general specifications of this type of drill are:

Length overall, air feed extended, 72 inches.

Length overall, air feed closed, 54 inches.

Weight, 65 to 80 pounds.

Piston diameter, 3 to 3¼ inches by 1 to 1¼ inches.

Steel, 1 inch to 1¼ inches.

A "Leyner" drifter at work in driving a tunnel through rock.

The problem of lubrication is of vital importance in the operation and the maintenance of rock drills. This question involves a wide field, and each phase of it will be discussed separately. First off, let us consider moisture in the air. With underground conditions it is impossible to deliver absolutely dry air to

An interior of a well-appointed underground blacksmith shop.

Air-operated shank and bit punch mounted on a No. 5 sharpener in the shop of a Michigan mining company.

drills, but it is feasible to prevent slugs of water from passing into the machines from time to time. The solution of this difficulty lies in providing plenty of receiver space, placed advantageously throughout the mine, and in installing pipe lines on a grade so that no pockets can be formed which could collect water. In this connection, a water leg or a small receiver, Fig. 14, is helpful in some remote corner or winze, or on a down grade. Moisture in the air washes the lubricant from the machines, which are run dry, with a consequent excessive wear of parts and a rapid falling off of drilling efficiency in the machine.

There have been placed on the market, from time to time, greases which are extremely harmful to rock drills. These are what are known as filled greases, and are usually inferior products. As a base, a fairly heavy body oil or light grease is used. Mixed with this, to give the product weight or body, are powdered substances. These powders are graphite, talc, chalk, and even mica. The force of the air blows the oil or grease through the machine, leaving the filler, whose value as a lubricant is nil. Even the graphite, at the temperature and the speed of a rock drill, does not lubricate. After the continued use of filled greases the ports become clogged with the residue, which is left there in an extremely hard state. The free passage of air is interfered with, and from time to time small chunks of this deposit chip off and are blown into the cylinder. Naturally, excessive wear, scored cylinders, and broken valves follow.

The light oils do not last long enough, and in order to keep the machine properly lubricated many applications of oil are necessary. This means lost time in oiling up, and the use of a great quantity of oil.

A word or two might be said here about the use of too much of any lubricant. The average miner thinks that by filling all the oil chambers and the inlet with grease at the beginning of a shift it should be sufficient for the whole shift. As a matter of fact, the amount of lubricant thus used is enough for three or four shifts. The working parts of a machine will hold but a certain amount of grease, and anything over that is only blown out of the exhaust and wasted. A machine thus lubricated will not stay oiled any longer than one which has been given just the proper amount, which will slightly cover all working surfaces. A wet type of drifter, stoper, or sinker should run a full shift on five or six cubic inches of grease of the right kind, intelligently used. Half that amount should do for a dry machine.

Now we come to the question of the selection of a lubricant. The various drill-machine manufacturers issue lubrication charts. These charts show numerous grades of lubricant for the different types of machines. All the grease and oil companies are placing on the market extremely suitable oils and greases for all makes and classes of drills. In consulting the charts, when choosing a lubricant, it should be remembered that in factory lubrication tests the work is carried out under ideal conditions. The air is as dry as it is possible to make it, the machines are new, and the test is carried on in daylight and under a roof, where things are clean. Under these conditions, a light-body lubricant shows up to best advantage. It has been found advisable for underground service to choose a slightly heavier lubricant than that

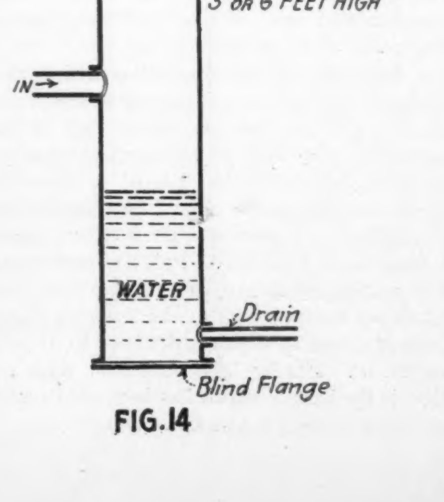


FIG. 14

recommended for a similar type of drill: the idea being that it will withstand greater moisture in the air and, in a measure, compensate for worn equipment. The heavier lubricant fills up the small spaces between parts which, with light oil or grease, would be leaks.

All types of drills have been and are at present equipped with automatic oiling devices. These consist of chambers, integral with various parts of the machine, and are so constructed as to hold quite a quantity of grease, which is fed to working parts by means of air pressure. In the older drills, the heavier body lubricants would not pass through the small feed holes. Further, it is found that, for underground service, the amount of oil or grease fed through these oiling devices is not alone sufficient for proper lubrication and that it is necessary to place grease directly in the air inlet of the machine. With the earlier types of drills this necessitated two weights of oil or grease, or the use of an unsuitable light oil or grease. However, at present, the automatic oilers are so changed and constructed as to handle a rather stiff grade of grease which is highly desirable under all working conditions.

The fact that there is more or less moisture in the air, as well as the use of wet types of machines, should cause us to select a lubricant which resists water well. That is, one that will not be readily washed out or emulsified. The grease should not be much affected by ordinary mine temperatures and should, at those temperatures, remain about the consistency of molasses, at 70° F. A grease of this consistency will take care of worn parts and will effectually seal the joints. The ideal lubricant should not be viscous, but should be smooth and free working. Steam and auto engine oils should be avoided on account of viscosity under ordinary temperatures. The ideal grease may be exemplified by "No. 4 Keystone" or by "Omega." There are other oils on the market that meet rock-drill requirements equally well. The writer has mentioned the two greases because he has tried them and they have been found ideal in every respect. Any other grease which possesses the necessary qualities will answer the purpose.

With greases of this kind all reservoirs and oil chambers on drills should be filled at the beginning of a drill shift. If the machines

are of the wet type, they should be filled again about the middle of a shift. After that, at intervals of from three-quarters of an hour to an hour, a piece of grease the size of a ⅝-inch hexagon nut should be placed directly in each inlet. This is sufficient for perfect lubrication, provided water is not allowed to run back into the machine from the water tube and no slugs of water come through the air hose. Any grease over the amounts given is only blown out of the machine and wasted. By following these methods in lubricating, the ends of the shanks of the steel will always show a slight film of grease. Shanks moist with grease show that every part of the machine is well oiled; and the slight oil film also acts as a light buffer between the striking end of the piston and the drill shank. This saves pistons and shanks to a far greater extent than is realized.

Air feed "stopehamer" drilling in New Jersey iron mine.

(*To be concluded.*)

NEW JERSEY GREENSAND MARLS RICH IN POTASH

IT HAS long been known that the greensand marls of New Jersey contain small quantities of potash, lime, and phosphate, the elements of a good fertilizer. For more than a hundred years they were dug and marketed for use as fertilizer, and in the late sixties the quantity so used annually amounted to nearly 1,000,000 tons. With the introduction of prepared fertilizers the greensand marl industry gradually died, but here and there in New Jersey small quantities of greensand are still dug and used.

It has been considered commercially impracticable to extract the potash from greensand because the mineral in which the potash is locked up—glauconite, a silicate of iron and potassium—is relatively insoluble. Of late years, however, many experiments have been made with the view of devising a process of extracting potash from silicates; and the greensand marls of New Jersey have attracted attention because of their accessibility and abundance and the relative ease with which they may be mined. The scarcity of potash caused by the shutting out of German supplies during the World War gave impetus to these experiments and encouraged the hope that a potash industry might be established in the United States, in which event the New Jersey greensands would be of high value.

The greensand marl belt of New Jersey extends across the state from the vicinity of Sandy Hook, at the northeast, to Delaware River near Salem, at the southwest, a distance of about 100 miles. It ranges in width from nearly fourteen miles in Monmouth County to one mile or less in parts of Gloucester County. It is crossed at many places by railroads and by streams that flow into the Delaware River. Moderate estimates show that the New Jersey greensands contain 256,953,000 short tons of potash (K_2O) that could be mined from open pits enough to supply the needs of the United States, as shown by the pre-war importation, for nearly 1,000 years.

AMERICA'S GIANT DIRIGIBLE NEARING COMPLETION

THE GREAT airship ZR-1, building at the Naval Aviation Station, Lakehurst, N. J., will probably be ready for service by the end of approaching June. From end to end, the craft will measure 680 feet and have a maximum diameter of 79 feet. Buoyancy will be assured by 2,000,000 cubic feet of helium gas confined in bags of "goldbeater's skin." The gas containers will be eighteen in number so as to minimize loss in case the envelope is pierced.

The fact that non-inflammable helium is to be used instead of highly explosive hydrogen is comforting in view of the disasters which befell the ZR-2 and the *Roma*. Whatever was the primary cause of the loss of those two earlier airships, there is no doubt about the catastrophes having been aggravated by the combustion of their large contained volumes of explosive hydrogen.

Aside from the gain in safety that is assured by the adoption of the somewhat less buoyant helium, it seems that the latter gas, for physical reasons, is not so apt to dissipate itself by leakage through the confining fabric. In other words, once filled with helium, the dirigible will be able to stay aloft and to travel farther than would be the case upon a single charge of hydrogen.

It has been said that the ZR-1 will have a cruising radius of 5,000 miles without replenishing either her propulsive fuel or her sustaining gas; and an areonautical engineer in the naval service is reported to have declared that the airship should have no trouble in making a non-stop run from either Alaska or Greenland to the North Pole and back again. The motive equipment of the ship will consist of six engines, built by the Packard Motor Company, each of which is designed to develop 300 H. P. Hardly less wonderful than the ZR-1 is the hangar which has been constructed for her and the ZR-3 at Lakehurst.

In days gone, simple tools, such as the pick and the shovel, were commonly used for ceremonial ground-breaking preparatory to building public institutions and the like.

The present picture, which shows the first breaking of ground for the construction of a $3,500,000 high school in New York City, illustrates how the pneumatic "Jackhamer" has supplanted the time-honored implements.

UNDERGROUND MINING FOR SLATE

ALTHOUGH open pit quarrying is the most common method employed for obtaining slate, underground mining is resorted to under certain conditions. Underground methods are now used at Monson, and have been followed near Delta, Pa., and West Pawlet, Vt. The mine at Delta was abandoned some years ago, and work was suspended at West Pawlet during the recent war.

Underground methods have been employed more extensively in foreign countries, both in Wales and on the Continent; a famous example being the slate mines at Angers, France, where overhead stoping has been used successfully for many years. The French mines are probably the most widely known on account of their unusual methods; but it is claimed that the Oakeley quarry in North Wales is the largest underground slate operation in the world—slate having been removed from 26 levels. It has 50 miles of railroads, four miles of pump mains, and twelve miles of compressed air mains.

Only under special conditions can underground methods be successfully followed. If the deposit is wide and relatively thin, or if the material is too unsound to form a safe roof, open-pit methods must be used, for slate is too low priced a commodity to justify the heavy expense of timbering. Where the deposit is relatively narrow, of great depth, and sufficiently sound to afford a strong roof underground mining can be followed.

European farmers, as a whole, are relatively well off, particularly those who put their war profits in real estate or farm improvements. The debtor class in Germany, Austria, and Hungary has profited by the depreciated exchange, and, in consequence, husbandmen are able to pay off mortgages of long standing by selling a few head of live stock.

COMPRESSED AIR METERS ARE MONEY SAVERS

By F. JOHNSTONE TAYLOR

COMPRESSED AIR is such a very useful accessory in many branches of engineering manufacture that installations of this kind form a big item in the equipment of innumerable industries, especially such as shipyards and steel construction shops, where pneumatic riveting, etc., is the order of the day, as well as in mining and quarrying. Air systems, however, are often unnecessarily wasteful.

While the modern compressor is both efficient and reliable, and while it is no difficult matter to keep the mains air-tight, the various lines, fittings, tools, etc., are frequently a needless source of waste, and this waste, moreover, in the absence of some sort of a meter, usually goes on undetected. This entails a loss of fuel or power, as the case may be, especially when it is considered that at a pressure of 70 pounds per square inch as much as twenty cubic feet of air per minute may escape through a ⅛-inch hole. It is little wonder, therefore, that air installations are occasionally considered unduly expensive. Some sort of a check on air consumption is most essential.

The installation of a meter in any air system is, therefore, nearly always worth the outlay. It is surprising the flow that will take place when every possible source of escape is supposedly shut off. Some interesting information on this subject was given in a paper on compressed air meters by John L. Hodgson (Transactions of the Institute of Mining Engineers, Vol. LX., Part 3). Several colliery engineers and other big users of compressed air gave instances of how considerable wastage was detected by the installation of air meters, proving the contention made in this article that they are without doubt a good investment. Not only is power saved, which means a distinct reduction in operating costs, but the air compressor plant can be used to its fullest advantage—such advantage being all the more apparent when really high-grade machinery is employed which is naturally expected to work efficiently and economically.

Instruments are now available for measuring the flow of air with considerable accuracy. In large plants, where the cost of a metering equipment is usually warranted, the Venturi principle can well be applied for the purpose. The arrangement is much the same as that employed for the measurement of water, its operation depending on the difference in pressure existing in a pipe line when part of that pipe line is purposely reduced in diameter. This section of reduced diameter is termed the "throat" of the meter; and the difference in pressure between that in the pipe proper and that in the throat is an accurate indication of the quantity of air passing through.

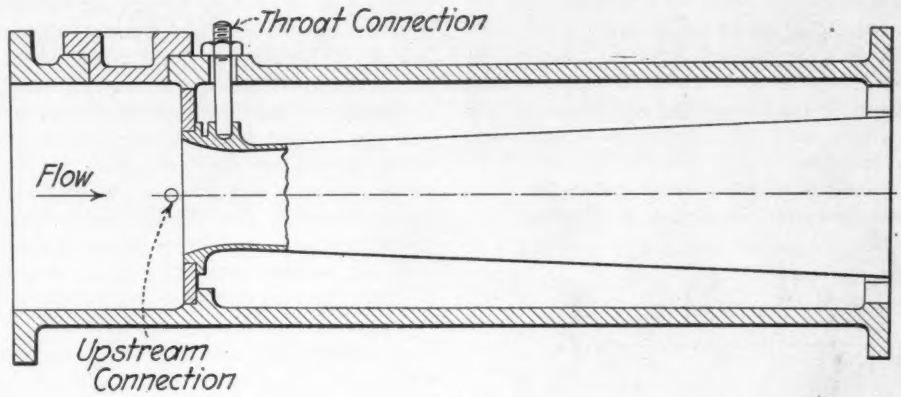


Fig. 2.

The Venturi tube, Fig. 1, consists of a converging up-stream cone, A, a short, parallel throat section, B, and a gradually diverging down-stream section, C. The difference in pressure, which is transmitted to the recorder, is that pressure which occurs between the full diameter of the main and the parallel part of the throat section. The function of the gradually diverging down-stream cone is to make it possible to recover a large proportion of this pressure difference, so that the loss of pressure, due to the insertion of the tube, may be reduced to a minimum.

If, after the Venturi tube has been installed, it is desired to increase the maximum flow measured, this can be done by fitting a shorter throat section to the Venturi tube; by adding a make-up piece to allow for the reduction in the length of the throat; and by altering the change wheels in the counter train of the recorder. It is necessary to make provision for this alteration when the Venturi tube and the recorder are originally designed and installed.

The "Orivent" tube, Fig. 2, is a modified and a cheaper form of Venturi tube. It is shorter, but its use involves a slightly higher pressure loss than is the case with the Venturi tube, that is, seven inches of water gage as against four inches at maximum flow. If the maximum flow measured is to be increased after the "Orivent" tube has been installed, this can be accomplished by fitting the tube with new internal parts.

For smaller compressed air plants, such as might be used in the ordinary run of establishments, simpler methods will give reasonable accuracy and cost less. The best known of these is the orifice meter, Fig. 3. This meter consists of a thin plate, A, interposed between two flanges on the delivery main. The two adjacent pipes are then connected to a manometer by small copper tubes. A manometer is a comparatively simple instrument that depends for its working upon the movement of a column of liquid in a "U" tube. The position of this column of liquid is controlled by the difference in the pressure that is exerted on both sides of the plate. As this is, in turn, proportional to the flow through the orifice in the plate, the position of the liquid in the "U" tube is a direct measure of the rate of flow. These "U" tubes are calibrated according to the formula

$$Q = \frac{100\,A}{\sqrt{\left(\frac{A}{a}\right)^2 - 1}} \sqrt{\frac{h\,p}{T}}$$

Where Q = cubic feet of free air per minute.
A = the area of the pipe in square inches.
a = the area of the orifice in square inches.
h = the "head" as shown on the "U" tube.
T = the absolute temperature thereof.
p = the absolute pressure therein.

This formula assumes the plates to be quite thin and the orifices to have square edges. A manometer of this kind is obtainable from various instrument makers, and the single-tube pattern is a good one because it has a more open scale than the ordinary "U" gage. The curved tube is another improvement as it has the advantage of an equally spaced scale practically down to zero. It is necessary that the orifice should be of an area properly proportioned to the average flow, and it must be accurately formed. It really is part of the instrument as a whole and should preferably be supplied by an instrument maker, although a good mechanic could easily make one. The orifice varies in size from one inch to 30 inches, and is individually calibrated for the particular conditions of pressure and for average flow.

A plate orifice, as shown in Fig. 4, can be made so that it includes a means for connecting the pipes for the manometer without having to drill the main for the nipples. This arrangement forms a complete unit which can simply be bolted in place between the flanges. In this case the plate is made to slant slightly, as illustrated, in order to give a clear entry to the pressure holes. It is important that the pressure pipes be laid with a regular slope

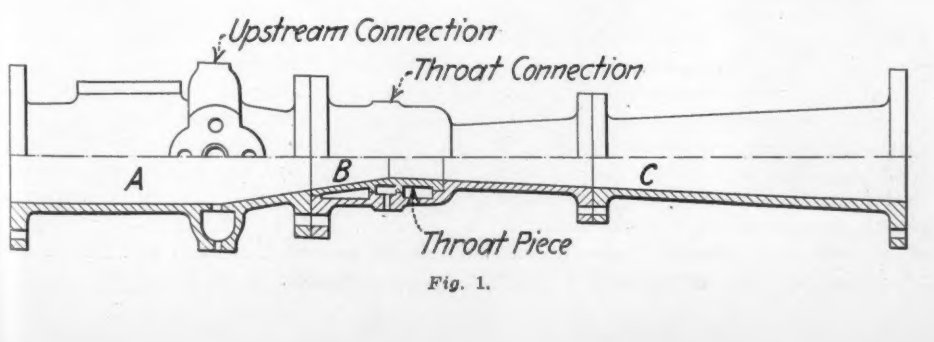


Fig. 1.

and that they be fitted with blow-off taps for the purpose of removing moisture. All sharp bends must be avoided, especially close to the mains. It is usual to place the recorder some distance from the orifice, the length of the connecting pipe then serving to "damp out" any pulsations.

In addition to the Venturi system for large installations and the orifice arrangement for

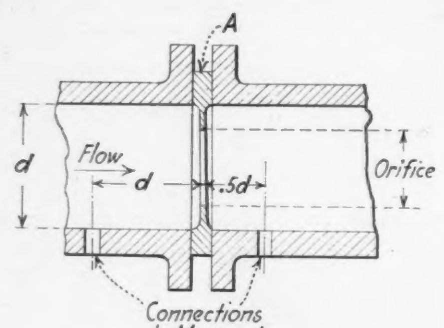


Fig. 3.

smaller ones, other forms of air meters are obtainable. Some of these utilize the mercury "U" tube instead of the manometer. This pattern is especially useful for portable meters. The latter have a set of dials or a means of "counter registration" in addition to a recording drum to show the total flow. If the latter only is required, and not the rate of flow at any instant, the turbine pattern of meter is satisfactory and accurate. These meters have been developed to meet those cases where the first cost of a Venturi tube or an orifice and a recorder is inadmissible.

The two principal defects of any turbine type of air meter are, first, that the nearly frictionless bearings, which it is essential to use, are liable to wear and to increase the friction, and, second, that the moving parts of the meter may become corroded or foul. These two defects can, to a great extent, be eliminated by the employment of special friction wheel bearings

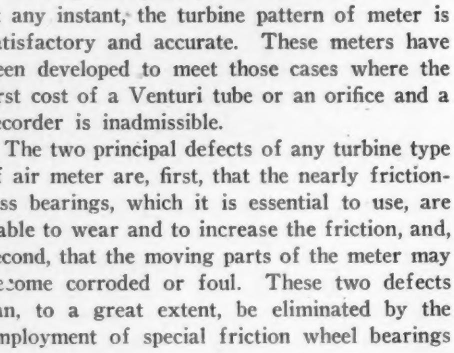


Fig. 4.

which are continually bathed in oil; by designing the meter so as to avoid deposits on the essential parts; and by a careful selection of the materials.

The special bearings referred to enable the axis of the rotor to be horizontal instead of vertical, rendering lubrication much easier and allowing the air to pass through the meter direct, instead of being turned twice through a right angle. The Kent turbine air meter registers by counter only, and measures the actual volume of passing air at the temperature and the pressure existing at the metering point.

The correction to be applied in order to obtain the flow of cubic feet of free air is directly proportional to the variation in the absolute pressure, and inversely proportional to the variation in the absolute temperature at the metering point. When these meters are used for measuring pulsating flows they must be placed at a point where the pulsations will be moderate. Turbine meters of this type are quite simple, and consist of but three parts, that is, the body in which the nozzle is fixed, a plate carrying the rotor and the counter mechanism, and the cover plate. The whole instrument can be easily removed for inspection.

For measuring pulsating flows, the gate type of meter is also often used. It is especially suited to the measuring of air passing on to rock drills and to other pneumatic tools of the piston pattern. As its name implies, it depends for its action on a gate, which swings with the pulsations of the flow; and there is nothing complex about this kind of meter.

ATTACKING THE BOLL WEEVIL BY AIRPLANES

IT IS estimated that in the last five years about $1,000,000,000 worth of cotton has been destroyed by the boll weevil, and the ravages of the pest are extending and increasing so that the plight of the planters is a desperate one. Various schemes of relief are being proposed and experimented with, but with no decisive success.

The most promising of all, and satisfactory as far as tried, is spraying the growing cotton morning and night with a solution of calcium arsenate that kills within a few minutes. This spraying can best be done, and has been done, by airplanes flying a few feet above the fields.

Three army planes, under the direction of the Department of Agriculture, are now to be employed for this work. Monetary restrictions do not permit the use of more planes at the present time; but the work of these, it is to be hoped, may lead to something decisive and of sufficient reach for the big job.

LEYNER SHARPENER PUTS HEEL CALKS ON MULE SHOES

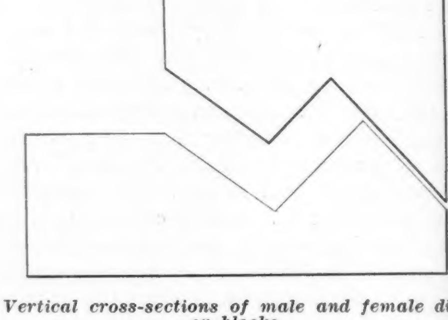
By WILLIAM WILHELM

AS A GOOD many of us know, the "Leyner" sharpener is designed and is used primarily for the sharpening of drill steels—in short, is a labor-saving device which enables the blacksmith to deal quickly and efficiently with a much larger number of steels than would be practicable by ordinary hand methods. The following little story discloses how an ingenious mind has devised a way to utilize the pneumatic sharpener in another helpful direction.

During a recent inspection of an installation of new sharpeners, my eye was caught by a set of rather odd-looking blocks in one of these machines, and upon inquiry I was told that the blocks were used for putting heel calks on mule shoes! Naturally, my interest was instantly aroused. It seems that the shoes reach the blacksmith shop without toe or heel calks, and these have to be put on by the blacksmith. Plainly, it is a pretty sizable job to calk shoes for 20 or 30 mules when the old method is used of bending the heel calks on the anvil. The problem is a very different one, however, when the sharpener is utilized for the job.

With the blocks in place in the sharpener, the shoe to be calked is heated in the forge and then put between the blocks. With this done, the operative lever is shifted to the first position which causes a blast of compressed air to blow away any scale lying upon the face of the dies. Then, by throwing the lever to the next position, compressed air brings the crosshead down; pressure is thus applied to the red-hot metal; and the heel calks are bent between the two blocks.

These blocks are nothing more than V-shaped dies, as the accompanying illustration



Vertical cross-sections of male and female dies or blocks.

indicates, and they are so designed that they do not pinch the shoe when it is being formed. The top block is a little shorter than the bottom one, and this is to prevent the toe end of the shoe from striking the top block and being bent out of shape thereby. These blocks are about an inch wider on the bending face than on the clamping surface, which latter fits into the place provided for the ordinary formers. By reason of this arrangement, the same blocks will do for calking shoes of any size that may be required around the colliery.

Putting the sharpener to this novel service saves not only time but enables the blacksmith to make certain that the same size calk is on each side of the shoe, and that the calks are square, as well. The number of shoes that can be turned out in this manner in the course of an hour is far greater than any demand that has yet been made on the machine in question. The blacksmiths told me that they could make heel calks with the outfit just as fast as two helpers could heat the shoes.

"The red-hot, revolver-at-your-head style of advertising" does not appeal to the people of South Africa, so it is said. It is a conservative country, and advertising matter sent there should be well illustrated, well written and in plain language.

Linking the Motor Truck With the Trunk-Line Railways

Automotive Vehicles for Short-Haul Service Promise to be Valuable Aids to Railroad Systems in Speeding Up the Movement of Freight

By JOHN LATHROP

CLOSER interrelation between motor-truck service and the steam railways of the country has been urged during the last few years by various transportation experts.

Upon study of the subject, it would appear reasonably established that the motor truck is peculiarly and admirably fitted to make the most of the short haul while leaving to the trunk lines the handling of the vast bulk of long-distance freight.

The accompanying article explains how and why this division of service and the co-operation between these two systems of transportation may do much to prevent the all-too-frequent recurrence of a so-called car shortage and congestion in the flow of essential commodities bound hither and thither within our continental limits.

WHEN THE YEAR 1922 passed into history, the United States moved to a new position in its consideration of transportation problems. The perfection of the motor truck, its development to a dependable, economic carrier, compelled a rewriting, so to speak, of the science of haulage, and made it necessary to turn to the engineer and to ask him to find the method that would best reform transport practices. Happily, the answer was forthcoming.

The turning point is based on what, to the average citizen, may seem to be a recent discovery, and may be outlined briefly as follows:

When a railway freight train leaves a station, bound for a distant terminal, it must run from 30 to 40 miles before it has paid, from the total revenue for the whole haul, the expenses incident to the operations at the starting point. It must run the last 30 to 40 miles to provide, from the total revenue of the whole haul, for the expenses to be incurred in handling the train at its destination terminal. The total revenue of the haul, therefore, must absorb the terminal expenses at both ends of the journey.

Consequently, a freight car destined for a point less than 30 to 40 miles away will be hauled by the railway at a loss or at an exorbitant and prohibitive rate. The short haul is non-profitable to the carrier. The longer hauls must carry that economic burden.

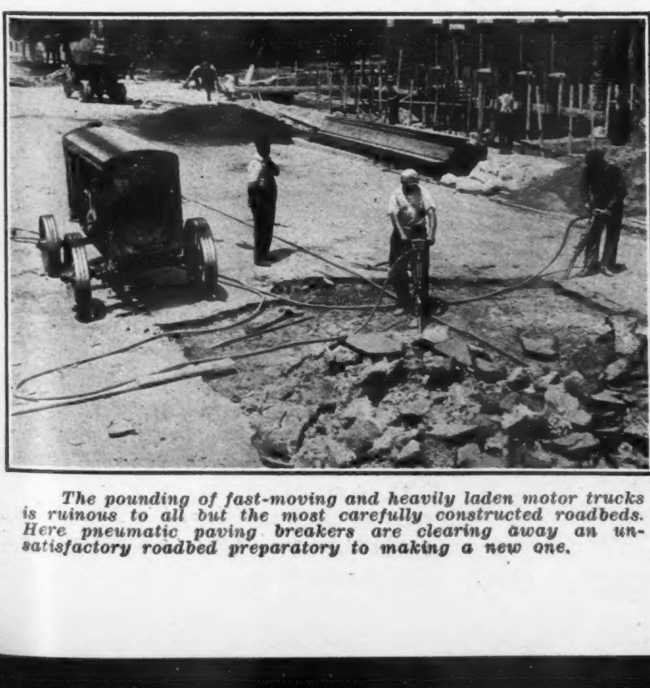
This fact, accepted now by all progressive transportation authorities, was, in effect, expressed ten years ago by the late James J. Hill, in a speech before the Railway Club of New York, when he declared that the problem of the standard railway was not one of car shortage, although, at that time, a so-called car shortage was the fairly general complaint of the manufacturer, the farmer, and the merchant. Mr. Hill averred that the true problem was lack of facile terminal movement of rolling stock and motive power. More prompt delivery of freight by rail lines would be possible not by adding equipment but by improving the terminals so that they would yield a larger average movement per freight car per day.

It was the best theory of transportation betterment which he could develop at that time. The motor truck had not been perfected so as to be regarded as a serious factor in railway freight service. The automotive vehicle was classed by the vast majority of people—and the railwaymen shared that complacent frame of mind—as a plaything, another luxury.

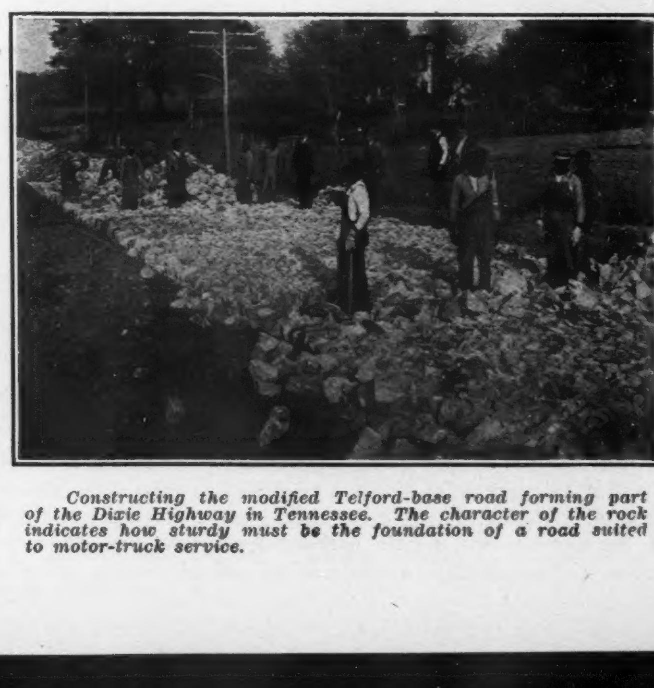
The evolution of the modern motor truck, its adaptability, its dependability, and the steady increase of the number in use, have, however, forced a change in the attitude even of railwaymen, who now regard it as complementary to the standard railway. Nowadays, they even consider it indispensable to the working out of transport problems. They accept the short haul by motor truck as essential under the existing circumstances.

Such advanced thinkers in the standard railway world as Elisha Lee of the Pennsylvania, Gerritt Fort of the Boston & Maine, T. C. Powell of the Erie, and others, admit the basic statement made by A. J. Brosseau, President of the International Motor Company, that the short haul by motor truck solves the immediately pressing problem, and that the motor truck thereby becomes not the competitor but the ally of the railroad. This leaves the railway the far more efficient service, the long haul, which is its legitimate and economic field, and releases railway facilities for better and more profitable business.

In order to clinch the argument for the sake of the doubting, Major Elihu C. Church analyzed a specific case of motor truck short haulage, which may be accepted as containing the basic principles involved. Major Church is transportation engineer of the New York Port Authority. As a member of the General Staff, American Expeditionary Force in France, he was an outstanding figure in planning and in operating the rail and the motor



The pounding of fast-moving and heavily laden motor trucks is ruinous to all but the most carefully constructed roadbeds. Here pneumatic paving breakers are clearing away an unsatisfactory roadbed preparatory to making a new one.



Constructing the modified Telford-base road forming part of the Dixie Highway in Tennessee. The character of the rock indicates how sturdy must be the foundation of a road suited to motor-truck service.

truck transport service for our army overseas.

"Although this particular instance chances to be localized in the City of New York and in contiguous New England territory," Major Church said, "it is typical of haulage everywhere, and applies in principle to every center of traffic movement in the United States."

though the figures may vary. The economy of short-haulage shipments by motor truck is as true in Chicago as in New York, in Boston as in Philadelphia, in San Francisco as in Detroit.

Furthermore, Major Church has added an interesting phase to these discussions, that is, he insists that the last 50 miles or so of haulage into a great terminal center such as New

It appears, therefore, from the analyses by Major Church, that motor truck short haulage justifies itself socially as well as from the financial standpoint of the standard railways. It assures existing values, and, besides, adds other values that will grow out of the promised solution of the present serious transport problems.

A motor truck and trailer moving milk in a flooded area. The inundation lasted seven days, but the delivery service was maintained without a hitch.

A truck and trailer, equipped with air brakes, forming part of a Western service which connects outlying farms with a populous, consuming center.

Major Church found that the several items involved in a rail shipment from a western Massachusetts factory to New York City, for less than carload lots, were: packing, $4.80 a ton; moving freight from the factory door to the freight car door, $3 a ton; and handling and trucking at the terminal in New York City, at least $3 a ton. In all, $10.80 a ton, not including the railway freight rate.

The factory could ship its product to the same destination by motor truck for $6 a ton, plus a trifling expense for packing. Inasmuch as the freight would be put right onto the truck at the factory door, and taken from the truck directly into the store or warehouse of the buyer, practically no packing cost would be entailed.

However, the big saving in transport cost is only one of the salient economies, as related to the interests of the shipper. If shipped by

York, Chicago, or Philadelphia, by reason of congestion, must be considered as a separate operation from the rest of the longer haul. He thus elucidates:

"A carload of freight is hauled, say, 1,000 miles to a congested traffic center. It might be that the haulage revenue on the 1,000 miles would absorb the excessive terminal costs at origination and destination, and leave a fair profit on the whole operation.

"However, if that carload of freight be stopped at some point outside the zone of actual terminal congestion, and the remainder of the delivery operation be done by motor truck directly to customer-destination, the cost will be less than if the load be left in the railway car, hauled into the congested terminal, and trucked from there to the customer-destination.

"If these facts and the savings be analyzed, it will be found that all three factors in the so-

We have piled such tonnage burdens upon the railways that they have not been able to move the freight with expedition. So-called car shortage has become a matter of course. One need only read the statements in the November, 1922, *Monthly Review* of the Federal Reserve Bank of New York to learn that—although railway managers, eager to improve the service, have endeavored to speed up the average per car per day movement of freight—"the normal average freight car haul was about 25 miles per day," and that "for the first seven months of 1922 it was only 22 miles." The *Review* goes on to show that by October 8, "a daily shortage of 143,000 cars existed." This condition continued, and while the number of cars reported short varied, at no time was there a material change in the status.

Secretary Hoover estimates that each of

The motor truck can move perishable fruits quickly from orchard to market and lessen greatly the likelihood of injury while in transit.

Here we have a motor-truck fleet laden with grain and engaged in expediting transfer between widely separated railway terminals of a large city.

rail, the freight would be thrown among the mass of already accumulated freight at the terminals, which are continually congested and taxed beyond their utmost capacity to move tonnage. Delay is ruinous, costly, and habitual.

If, then, this case be applied to other cities, and to other classes of freight for short haulage, the elements will remain unchanged al-

cial economic whole, the carrier, the shipper, and the consumer, to say nothing of the motor truck operator, will benefit. It is, therefore, necessary to examine any proposal for a newer method of freight haulage in the light of those three classes, for a plea for it will fail unless the system means ultimate economy for the masses."

these periods of so-called car shortage cost the American people not less than $1,000,000,000. The losses are suffered by merchants who receive goods so late that they are unsaleable because they have become unseasonable; by manufacturers owing to delay in receipt of raw materials and in forwarding the product; by workmen on account of the shu

ting down of all or of parts of plants awaiting the arrival of materials; by farmers whose crops rot in the fields or in the farmyards; and, finally, by everyone in the freezing of invested capital which may be thawed and made fluid for productive processes only by ending inordinate delays in the delivery of freight.

It is one thing to point out the economic weakness of an existing system of haulage—although that is the first logical step—but quite another thing to outline the more vital remedy. The remedy must not be the conception of the superficial opportunist. It must come from someone farsighted enough to provide a system that will take care of future expansion and which will take into account every basic factor in the social and economic whole.

While the automotive industry has given us a thoroughly reliable and efficient vehicle, the manufacturers and the truck operators freely acknowledge that, unless there be a complete organization and coördination of all of the factors of the transport service, this valuable contribution to social progress will fail to fulfill its part.

There are today in commission in the United States about 12,000,000 automobiles, 11,000,000 passenger cars and 1,000,000 trucks—84 per cent. of all the automotive vehicles in the world. At the present rate of production—that is, for the latter half of 1922—five years will give us about 20,500,000 cars in all, even though we write off one-third of those in use in the meantime.

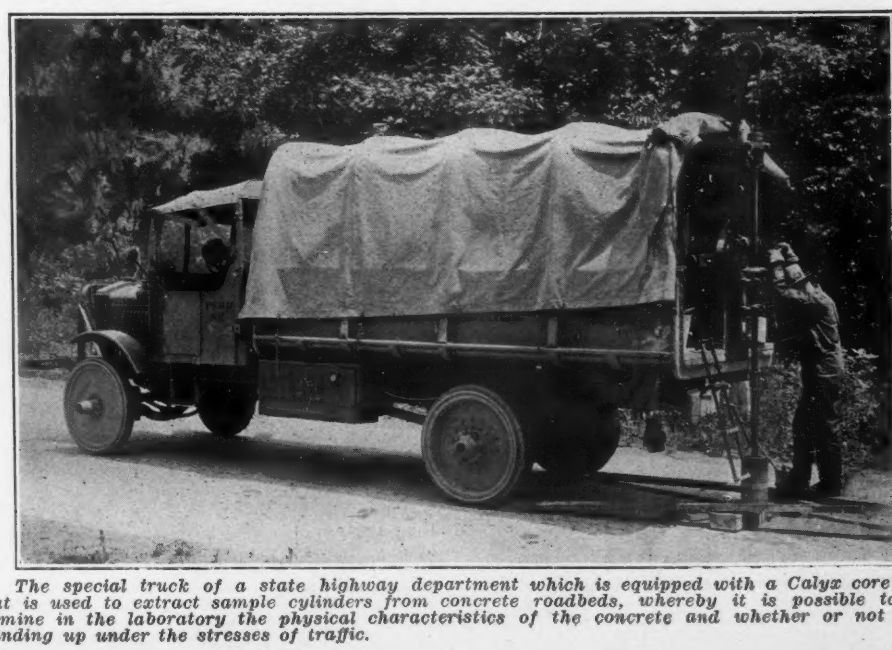
As conditions exist, we are approaching the point of saturation in many places. Additional supply will cause a geometric increase, and trouble due to street and country highway congestion will grow as the square of the increase of vehicles. At the same time, each step toward a resumption of normal business and industrial activity will intensify the so-called car shortage. Any proposal, then, that points the way to a prevention of the threatened traffic tangle should have careful consideration.

Many eminent transportation experts have declared that the broad, comprehensive plan of Major Church does take into account all of the basic factors of the problems. His plan, in brief, comprehends recognition of the economy of the motor truck for short haulage; the relief of standard railway terminal congestion; the release of railway facilities for the more efficient longer hauls; the development of a system of "motor truck trunk line highways" designed to meet traffic requirements; belt lines around congested centers for the more facile movement of through haulage; the utilization of shallow waterfronts in coördinating rail, canal, and river haulage; and, most important of all, the development of a system of traffic control fashioned, in principle, on railway train dispatching. It involves the employment of streets and highways so as to level the traffic "peaks" and to insure a regular movement of vehicles as well as a reduction of accidents. It is, in brief, the peace-time application of the methods of the American Expeditionary Force in France.

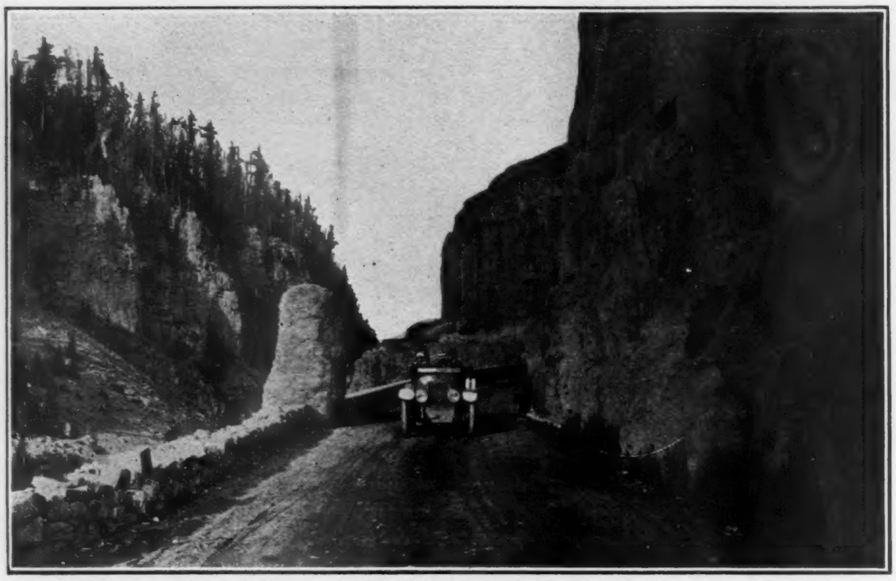
Essential details in the execution of the plans include the more extensive use of the traction motor with one or more trailers pro-

More and more the mobile portable compressor is figuring in the construction of highways in difficult sections of the country and serving in this way to link outlying districts by motor truck with the trunk-line railways.

A portable air compressor operating two "Jackhamers" on a Federal-aid road project, which is located in a mountainous section of Virginia. The work is blazing the way for the wider use of motor trucks.



The special truck of a state highway department which is equipped with a Calyx core drill that is used to extract sample cylinders from concrete roadbeds, whereby it is possible to determine in the laboratory the physical characteristics of the concrete and whether or not it is standing up under the stresses of traffic.



Pneumatic tools and blasting made it possible to clear away the rock in building this road for automotive vehicles.

vided with air-brake equipment—the latter an important operative feature. In time, we shall see a driver leave Philadelphia with a motor truck and, perhaps, two or three trailers; shall find him dropping one trailer at Trenton, another at Rahway, and still another at Newark; and, if we follow him to the end of his journey, shall discover him delivering the load on the pulling truck in Greater New York.

However, if the load be destined for Harlem, at the northern end of Manhattan, it will not be hauled into the already jammed streets in the lower part of the island; but, instead, it will be taken on a belt line to a point, say at Fort Lee Ferry, directly opposite Harlem, and then across the Hudson River.

But losses due to congestion will be prevented only when highways and belt lines are constructed with no sharp turns and with minimum grades on the principle of the standard railwayman's guide of "the ruling grade." There should be no heavy gradients; and, if they cannot be avoided, then every possible device should be called into service which will contribute towards the upbuilding of a thoroughly satisfactory system of transportation.

Mr. D. C. Fenner, of the International Motor Company, thus sums up the situation:

"One may easily see in his mind's eye a motor-truck highway between Philadelphia and New York; but, it seems to me, in the procurement of that highway, suited to the needs of the situation, we shall have to look at the problem much as though we were going to build an edifice which is to extend the entire 90 miles. It must be so constructed that it will settle evenly, and retain all of its relative levels.

"In other words, I can see men at work going over the proposed highway with portable compressed air outfits to drive pneumatic tools; taking soil and subsoil core samples; and studying these soil samples to learn what must be done to construct permanent roads and to overcome the arch enemy of road-builders, water.

"Already, the tractor-and-trailer method of transportation is in successful operation. For instance, since 1918, the Liberty Highway Company of Toledo, Ohio, has given a regularly scheduled service between Toledo and Detroit, using the air-brake equipment; and at this time has five tractors and ten trailers at work. Our reports are that the equipment is efficient and that the service is satisfactory and economical."

All of these and other details are embraced in the development of the comprehensive and the permanent construction plan of Major Church. Taken together, they are the scientific realization of that significant saying by a wise man in years past—"that we should spend absolutely no money on our streets and highways; but should, instead, invest our money in our streets and highways."

No person of short vision will contribute helpfully to this discussion; and, on the other hand, no one who is visionary can be of assistance. He who "keeps his feet on the ground but who lifts his eyes to look ahead" can and will find the answer.

In his well-formulated, comprehensive plan, Major Church has adhered strictly to established rules of engineering and operating; has drawn on experience and scientific proof; and has, at the same time, surveyed the pathway ahead so as to make sure that as we advance we shall not have to retrace our steps. Thanks to his labors we shall be able to go ahead more confidently in working out our transportation problems, which have staggered the Nation and have given food for thought to some of our greatest men.

With the discovery of large deposits of very rich, easily worked radium ores in Katanga, Belgian Kongo, the price of elemental radium has dropped from $120,000 to $70,000 per gram. A plant has been erected 40 miles from Antwerp, Belgium, for the production of the precious radio-active mineral from those ores.

There are in the United States today more than 14,000 oil producers operating over 275,000 wells, which yield at the rate of 1,500,000 barrels of oil a day.

WHY GEYSERS ERUPT

GEYSERS have often been compared to volcanoes, presenting in miniature as they do, with water instead of molten rock, all of the characteristic phenomena of a volcanic eruption. The source of the heat which causes this outburst is the hot lava, lying beneath the earth's surface, and which is part of the volcanic nature of the region wherein geysers are in evidence.

The accepted theory of these natural steam generators is that the boiling point of water rises with the local or enveloping pressure, and that the temperature of water in the bottom of a tube is, therefore, higher than that near the top or at the surface. In the deep, narrow, and irregular vertical passages or tubes of geysers, the ebullition of the water in the lower section is, accordingly, the consequence of much higher temperature by reason of the hydrostatic head or the weight of the superposed column of water.

The heat transmitted from the adjacent lava when continuously applied to the water at the lower limits of the geyser tube causes the temperature of the water to be raised to a high degree, while the water above and close to the surface still remains cool. Eventually, the bottom water reaches the submerged pressure boiling point and is converted deep underground into steam which, in its turn, lifts the rest of the water overlying it and causes the latter to overflow or to gush upward. This movement alters or lessens the hydrostatic head of the mounting column of water, and by thus reducing the pressure brings the hot water to a point where it is able to boil. The sudden generation of steam induced in this fashion brings about the ejection with great violence of whatever water still stands between the steam and the free atmosphere. The water that is forced out at the ground level flows back again into the geyser tube or percolates through the porous lava, descends, is again heated, and the cycle starts anew.

Small geysers gush every few minutes, depending on the intensity of the promoting heat; while the interval between the eruptions of larger geysers may be a matter of days or even weeks. "Old Faithful," in Yellowstone National Park, usually performs every 65 minutes; and in an interval of four minutes it will throw about 200,000 gallons of water skyward to a height of from 120 to 170 feet.

HEAVY OIL FOR AUTOMOBILE

UNDER control of the Automobile Club of France, an interesting test was made recently with an automobile using crude or heavy oil in comparison with another using gasoline. Two cars, identical in every respect were used, except that one had a 15 H. P. oil motor and the other a gasoline engine. They made a trip from Paris to Ferté-Bernard and back, 207 miles, at an average speed for both of 31¼ miles per hour. The consumption of gasoline was 3⅓ gallons for 62 miles and of heavy oil slightly less. The cost of the gasoline was four times that of the petroleum.

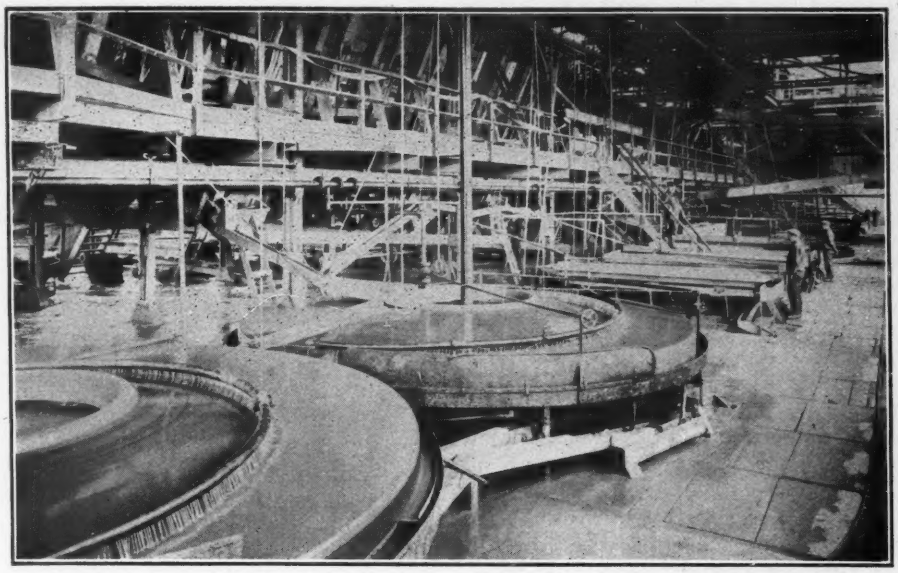
A THOUSAND-YEAR-OLD MINE STILL BEING WORKED

By ROLAND H. BRIGGS

IN THE tenth century, so legend has it, Otto I., arriving at his castle in the Harz and finding the royal larder short of venison, sent his hunter Ramm out to the forest to kill a deer. The winter snows were on the ground, and the hunter soon found a fresh track which he followed far up into the mountain. As the way became steeper he was forced to dismount from his horse, which he left tied to a tree, and to follow his quarry on foot. The chase was a long one; and the high-spirited steed, left alone in the cold, impatiently pawed the ground, scraping away the snow and earth and laying bare the rock beneath.

When Ramm returned from his pursuit of the deer he was astonished at the glint of metal beneath the hoofs of his horse, and he hastened to collect pieces of the ore—the first specimens to be taken from the Rammelsberg. The delight of King Otto at the discovery was great; and he rewarded his hunter by giving him a golden chain, worth 1,000 ducats, and by naming the mountain "Rammelsberg," to perpetuate his retainer's name. Little did either King Otto or his hunter dream that centuries later the descendants of the pioneer miners would still be digging and delving in the bowels of the Rammelsberg not aided, to be sure, by fire and the Devil but assisted, instead, by compressed air. Any miner will tell you that the Devil once really worked in the Rammelsberg; and the Devil's Pit, as it is known, may be seen there today.

Goslar, the mining town in which the Rammelsberg is located, is said to have been founded by King Henry I. in the year 924. It is probable that he worked the mines to some extent or, at least, knew of their existence. Some traditions would have it that Rammelsberg mining began still earlier; but the legend of the hunter Ramm and of King Otto would place the date of the first commercial production of ore from this ancient mine about the year 968. Otto I. brought skilled miners from Frankenland to sink the shafts and to open up Nature's hoard, and, gradually, more and more workers came to the district. Consequently, Goslar grew to be an important mining town.



Ore concentrating tables in the smelting works at Goslar where lead from the Rammelsberg mines is treated.

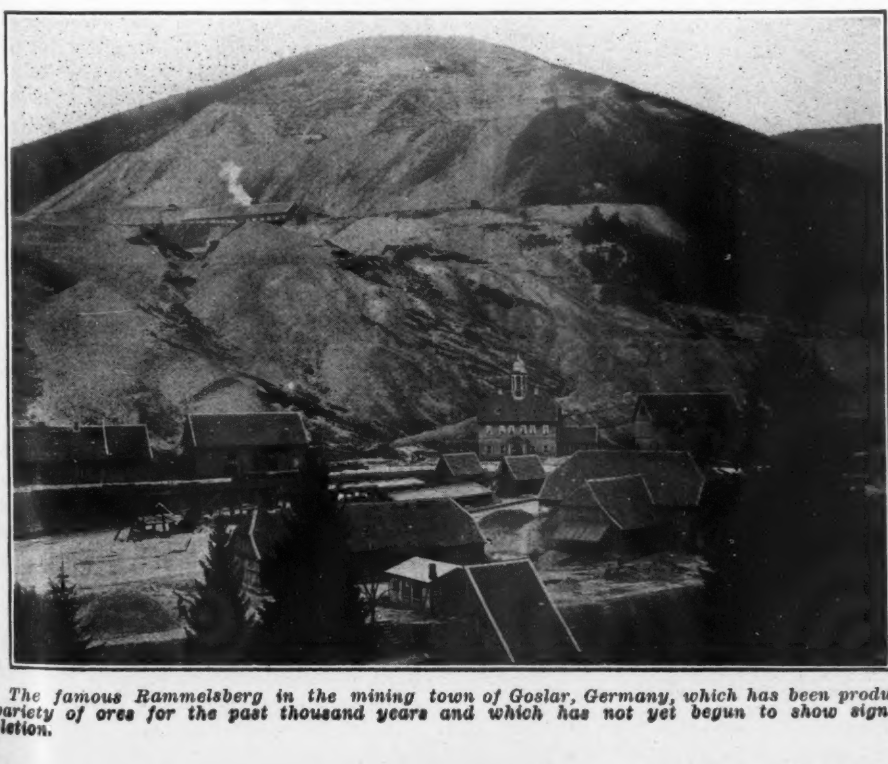
The great riches, and the variety of the ores found in the Rammelsberg have made it world-famous. Gold, silver, copper, lead, zinc, iron, manganese, cobalt, nickel, bismuth, barium, arsenic, sulphur, antimony, quicksilver, cadmium, and other metals are taken out of this mountain; and the output in 1913 amounted to over 60,000 tons of lead and copper ore.

The dwellers in the Harz region in the tenth century were Saxons, and as they had no knowledge of mining Otto I. imported skilled miners—Franks from the Fichtelgebirge. The name Frankenscharner Hütte, given to the great smelting works near Clausthal, is doubtless derived from this source, just as the name Sachsenstolle, by which a large adit near Clausthal is known, came from the Saxon miners who learned mining from the Franks.

There is little more of importance known with regard to the early history of the Rammelsberg up to the year 1005 except the fact that before that date King Otto had produced coins from the silver mined there—probably the first made in Germany. The terrible plague which ravaged that country in the reign of Henry II., from 1004 to 1008, levied a heavy toll of human life in the Harz, so that mining there ceased altogether for the decade from 1006 to 1016. The industry was then revived; and through it the town of Goslar became important. From 1105 to 1111 the Rammelsberg mines were again closed; and in 1181 they were destroyed by Henry the Lion in a fit of resentment against "Barbarossa"—evidence that miners seemingly had as many troubles in the "good old days" as they have at the present time.

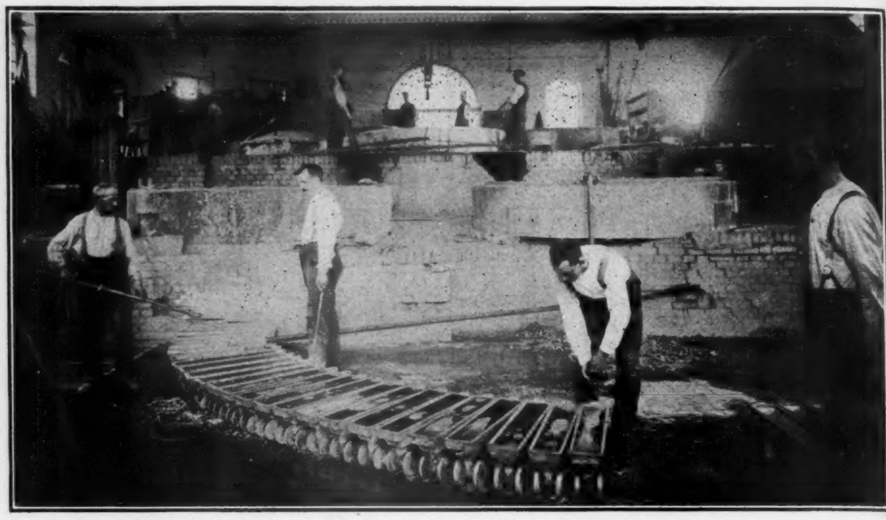
In 1157 the Rammelsberg mines were split up among various owners, but later on they all came into the hands of the town of Goslar, subject to royal prerogative. In 1170, lead carriers, who were taking metal from Goslar into Bohemia, noticed lead ore in the road they were traveling, and right there sprang up the mining town of Freiburg and the industrial center of which it is the heart. Following the action of Henry the Lion, the mines were not again worked until 1209—28 years after their destruction—when Otto IV. resumed operations which were continued uninterruptedly for nearly a century and a half. Soon after the year 1219 the foundation for the Goslar mining laws was laid.

The mining industry of this section of the Harz had much to contend with in the way of droughts, land slides, fires, etc., with the result that all work in the Rammelsberg ceased once more from 1353 to 1453. But from that time on to the present day, in spite of the interference caused by the Thirty Years' War and other great political events which shook Europe, the mines have remained in operation and are likely to continue to do so for many decades to come.



The famous Rammelsberg in the mining town of Goslar, Germany, which has been producing a variety of ores for the past thousand years and which has not yet begun to show signs of depletion.

Three very important steps may be said to have contributed to the success of mining in the Harz, and to its support in times of stress. These three steps were: the organization of mining banks, the establishment of the mining corn granary, and the granting of mining freedom. The corn granary was begun during the Thirty Years' War, and kept down the cost of living for the mining population in the Harz. The mining banks, which were of still greater importance, were formed in the year 1703. The banks were organized so as to help to maintain and to develop the mining district, taking over shares of pits being worked at a loss but showing good prospects. When any such pit began to make returns, the bank concerned profited accordingly, and this was especially the case with the Clausthal bank, which grew very rich in consequence.



Casting pigs of lead in a refinery near the Rammelsberg.

In 1552, Goslar was forced to relinquish all of its claims to the Rammelsberg, which then became a ducal possession. Between the years 1521 and 1556 the public rights to mine in the Harz were granted. These were of such a liberal nature that miners from as far away as Bohemia were attracted and settled in the district. Everybody was allowed to prospect for ore to his own profit, provided he gave to the landowner one-tenth of the ore mined; made him the first offer of the ore at a fixed price; and submitted to the local mining laws. In return the landowner conceded the miner many privileges; he got free timber for the mines; had free markets in the towns; generous agricultural and grazing rights; the benefit of special civil and mining courts, and freedom from the jurisdiction of the ordinary courts. In short, every inducement was offered to encourage the mining industry in the Harz which, consequently, flourished despite the severity of weather conditions, the absence of other business, and, until the Harz railways were built, poor transportational facilities.

The Rammelsberg is of as much interest geologically as it is historically. It consists of three strata of the Devonian age which, though originally horizontal, were first folded and finally inverted under enormous side pressure so that the lower stratum now forms the summit of the mountain. This consists of under-Devon sandstone, and extends from the top about half-way down the mountain. It is very largely quarried for roadstone. The next stratum is middle-Devon slate, and the lower stratum upper-Devon Goslar slate. A great deal of this slate is used in Goslar for the construction of dwellings.

As has already been mentioned, the Rammelsberg is rich in minerals, the principal ones of which are lead and copper. The mineral formations which are now being worked are the product of the disintegration of earlier formations, and, owing to the action of air, water, and heat, they are now a very hard mass which, until the advent of the rock drill and blasting materials, could only be mined by the aid of fire. The Rammelsberg is drained by two underground adits, which were constructed in the fourteenth and the sixteenth centuries, respectively.

The pneumatic drill is now employed to drill blast holes in the face of the very hard rock formation as found in the Rammelsberg.

The Rammelsberg is located in the large mining area which stretches from northern Hannover to St. Andreasberg, and of which Clausthal is the center. In this ancient and interesting town is situated the well-known mining university where so many mining engineers the world over have received their technical training. By courtesy of the director, the writer was permitted to view the institution's fine collection of minerals, with its 5,000 beautifully arranged specimens, as well as the exhibit of models of both past and present mines and mining equipment. Here may be seen, among other things, models of the old shafts and hoisting arrangements as formerly used in the Rammelsberg.

The Rammelsberg still stands today as it did a thousand years ago despite man's persistent effort to disembowel it and to bring its treasures to light. No one has yet predicted when mining there will cease; but one thing is certain, and that is that with the advent of the pneumatic rock drill and other compressed air equipment "Ramm's Mountain" will be forced to give up its riches much faster than it could possibly be made to do with the old-fashioned tools in the hands of even the Devil, as legend recounts.

A site has been chosen for an international bridge at Tientsin, China, which is to be either of the bascule or rolling lift type.

Still Improving the Tractive Power of the Steam Locomotive

Compressed Air Figures Conspicuously in Making this New and Very Powerful Engine Efficient

By S. G. ROBERTS

DON'T START something you can't finish! This caution may apply aptly in many departments of life, but the situation is exactly the reverse in railroading. There, fully half of the transportational problem is made up of getting things started—things, to be explicit, being another term for trains.

Just as we have seen horses struggling with all their might on a slippery footing to get a heavy load in motion, going forward with comparative ease after they have succeeded, so a locomotive makes a kindred effort to start a ponderous train—acceleration being seemingly a far less strenuous matter to accomplish. Because of the difficulty in getting long and laden trains under way, it is a familiar sight in freight yards and at the foot of grades to see pusher engines brought into service to help out the leading locomotives. In other words, to bring increased tractive power into play.

When the rails are wet or slippery from any state of the weather, the task of the locomotive is made a harder one; and if the train has to slow down to a snail's pace or come to a halt the resumption of headway may be impossible without the aid of another engine. Indeed, the stop may occur at a point where a considerable delay will be experienced before a helping locomotive can be secured. Further, even under fairly favorable conditions, the stopping and the starting of a train are always an item of expense; and the total outlay for transportation is increased by every unscheduled halt.

It has been authoritatively estimated that there is a money loss or outlay of about 50 cents every time a train is brought to a standstill and started again. This, of course, is merely an average. The actual figure varies and may be considerably higher than this, depending upon the length of the imposed stop; the maximum running speed called for by the schedule; the character of the train; the pay of the train crew; and the amount of fuel burned. The ultimate losses may be larger still if the movements of other trains are interfered with and the operations at terminals are disrupted.

Reduced to its plainest terms, the number of cars and the tonnage which any locomotive can pull satisfactorily are, in the main, fixed by the starting power of the engine. Recognizing this, the New York Central Railroad, about a year ago, took in hand the building of a greatly improved "iron horse," which was designed to show that steam traction was not obsolescent, as has so often been proclaimed of late by some of the over-zealous advocates of trunk-line electrification.

The engineering experts of that thoroughly progressive railway system set about designing and constructing a freight engine which should be the most powerful locomotive of the Mikado type in existence. Their labors, which were brought to an effective climax at the Lima Locomotive Works, Lima, O., were crowned with noteworthy success when that remarkable tractor was put to the test. "Super-locomotive No. 8000," during a demonstration run, disclosed that it could handle, without aid, a train composed of 140 cars carrying more than 9,000 tons of coal! In fact, its reserve of power indicated then that it could draw 150 cars each of 80 tons burden—a total of 12,000 tons of freight.

When it is recalled that coal trains of 6,000 tons were previously considered exceptionally heavy, and were comparatively few in number, we can realize the significance of what has been done by the New York Central Railroad in bringing out the class represented by "No. 8,000." Despite all that has been said and is being said about car shortage, the fundamental difficulty is not due to a lack of cars so much as it is a consequence of slowed-up movement and over-worked available locomotives. The volume of freight offered for transportation has, taking the nation's trunk lines at large, been too much for them. The rapid multiplication of engines like "No. 8,000" should prove a potent factor in reducing congestion and in speeding up all kinds of commodities in transit.

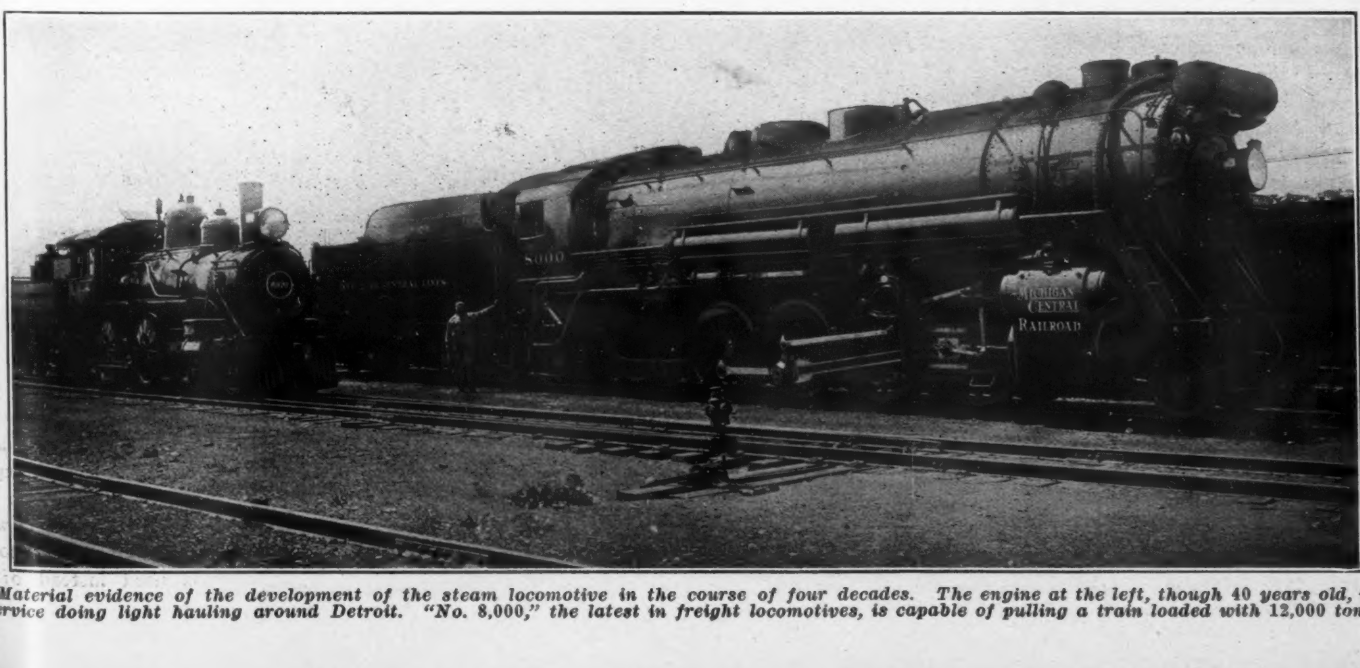
According to the experts of the New York Central Lines, "No. 8,000" is deemed the last word in efficiency and economy for the service intended, which is that of expediting the movement of heavy, fast freight trains and, especially, refrigerator trains laden with perishable foodstuffs. We are told that the engine has three outstanding claims to distinction. These are:

1. For its weight, it will deliver more power than any other locomotive in the world.

2. It will exert more tractive effort, per ton of coal consumed, than any locomotive hitherto built.

3. It will prove easier to operate and to repair than any of its predecessors, and thus will facilitate quick turn-rounds and promote safety.

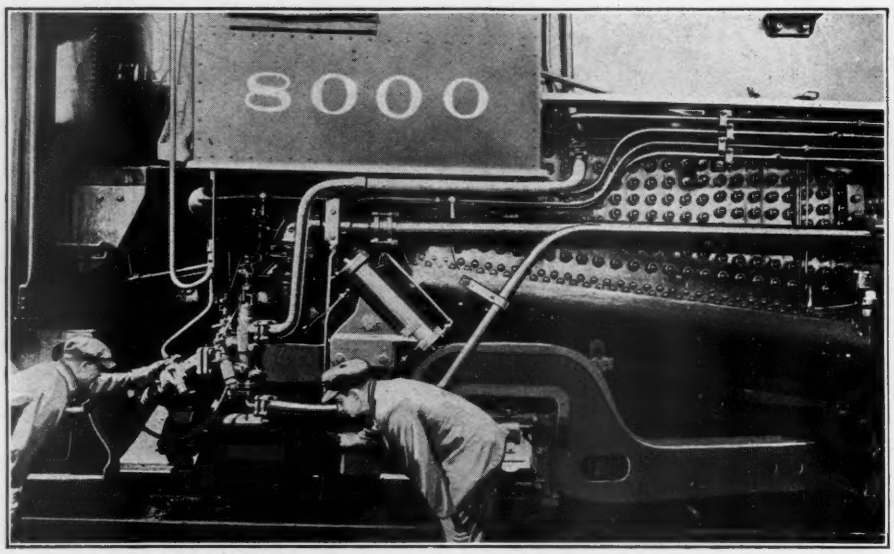
No small part of the improvement typified by "No. 8,000" is due to refinements in design and to the use of alloy steel, hollow axles and crank pins, and other features which have made it practicable to eliminate a goodly measure of weight heretofore considered necessary to insure the required ruggedness and strength. Without going into technical details, it may be stated that with an increase in weight of less than 2 per cent., as compared with the heaviest of Mikados in use on the company's lines, the new engine can boast a total augmented tractive power of something over 26 per cent. Fully



Material evidence of the development of the steam locomotive in the course of four decades. The engine at the left, though 40 years old, is still in service doing light hauling around Detroit. "No. 8,000," the latest in freight locomotives, is capable of pulling a train loaded with 12,000 tons.

18 per cent. of this gain is due to a novel auxiliary called a "booster," by which the trailer wheels of the locomotive can be made to act as driving wheels.

Prior to the development of the booster, which is an engine that can be geared to the trailer axle and be brought into service at the will of the man at the throttle, the trailer wheels did nothing more than carry the weight of the rear end of the locomotive. They were idlers, so to speak. As at present arranged, the booster, when "thrown in," supplements the advancing effort of the locomotive —it is incapable of reversing; and when the booster is "cut out" the trailing wheels revert to their normal function. The purpose of the booster is to amplify the tractive power of the locomotive when getting under way or when contending with especially taxing stretches of rising gradients; and this is made economically possible owing to the surplus energy which the boiler is capable of producing.



A close-up of "No. 8,000" disclosing some of the details of the booster which turns the trailer wheels into driving wheels capable of exerting a tractive power of 11,000 pounds.

For the sake of those interested in engineering details, it seems that the weight of "No. 8,000," exclusive of its tender, is 334,000 pounds. The tender weighs, when loaded, 199,700 pounds, and carries sixteen tons of coal and 10,000 gallons of water. Of the 74,500 pounds of tractive effort developed by the locomotive when starting off with a heavy train, 11,000 pounds are due to the booster, while the remaining 63,500 pounds are the consequence of the drive or impulse of the regular cylinders at the forward end of the engine. As will be seen, 14.8 per cent. of the aggregate propulsive force is exerted by the booster; and, with this increased grip upon the rails, the super-locomotive is able to start things and to keep going on slopes that would stagger any other engine of the Mikado type and approximate weight. Incidentally, "No. 8,000" is able to pick up its full speed much quicker than would be feasible without the booster, thereby shortening the interval between stops and the resumption of maximum headway.

The main cylinders are 28 inches in diameter, with a piston stroke of 30 inches, and a boiler pressure of 200 pounds is maintained. The driving wheels have a diameter of 63 inches. As might be expected, the most is made of superheated steam; and it is said that for the first time in the history of American railroading superheated steam is used to operate the air pump, the feed-water pump, the booster engine, and the turbo-generator for the electric headlight. While the locomotive is equipped with a regulation injector, this is supplemented by a feed-water pump which takes the water from the tender and forces it through a heater and into the boiler. The heater is kept hot by exhaust steam, and the condensate from this steam is returned to the tender through a filter. In this way, any oil is eliminated which might pass over from the cylinders.

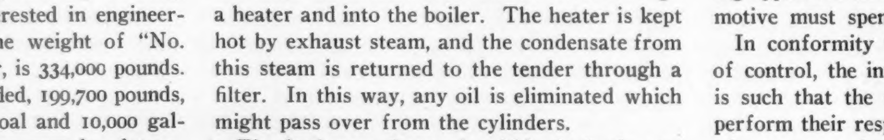
The feed-water heater is within the horizontal tank mounted above the headlight. This arrangement insures an ample fall for the condensate flowing down and backward to the filter on the rear of the tender. By way of another important departure, the operative steam for the driving cylinders is superheated before it reaches the main throttle. In "No. 8,000," the steam from the boiler passes through the steam dome into the dry-pipe and thence to the superheater units. Before the steam leaves the dome it travels through a separator which collects any water that may be carried by the steam; and the water so extracted is automatically returned to the boiler. By this provision and by taking the steam from the highest possible point, absolutely dry steam of an unusually high temperature is assured.

On leaving the superheater, the steam is led to a throttle-box, so called, placed on top of the boiler and between the smokestack and the superheater. This system makes for a short and notably direct route for the steam from the throttle to the main cylinders. Everything that experience and ingenuity could suggest has been provided to enable the enginemen to handle the locomotive with ease. Among the various special equipment devised for this purpose are a novel power reverse gear, an automatic stoker, and an automatic grate-shaking apparatus which shortens the time the locomotive must spend over ash pits.

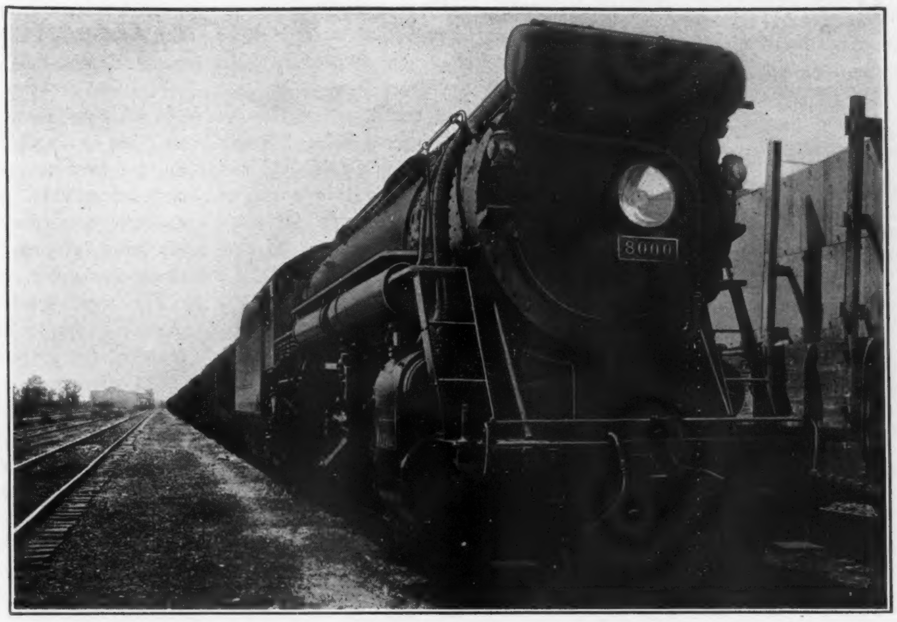
In conformity with the aim towards facility of control, the interior arrangement of the cab is such that the engineer and the fireman can perform their respective duties with a minimum of movement from their assigned positions on either side of the cab and with little if any real physical effort. And now we come to the various services performed by compressed air which are both labor saving and, in some particulars, decidedly unique.

The function of the air pump on all locomotives as a part of the train-braking system is well known, but in the case of "No. 8,000" the designers have found a goodly number of other uses to which compressed air can be put advantageously. The engine is provided with two air receivers or tanks, each 18½ inches in diameter and 120 inches long; and in them air is maintained at a pressure of 110 pounds. It will be noted that this pressure is a little more than half of that of the steam in the boiler; and the lower pressure of the air explains in part why pneumatic control is resorted to in the ways to be described. Let us explain.

Operative parts can be made lighter where a pressure of 110 pounds is used instead of one



The tank at the front of the locomotive and above the headlight is the feed-water heater. Immediately back of it and in front of the smokestack is the throttle-box from which operative steam is fed directly down to the main driving cylinders. The tanks which hold compressed air are seen well above the engineer and parallel with the boiler.



Super-locomotive "No. 8,000" hauling a loaded train of 140 cars during a test run.

of 200 pounds, and this means a saving in weight and in initial cost. Next, by substituting compressed air for steam, troubles from condensation are greatly reduced; and this is a matter of considerable moment, especially where piping, cylinders, etc., are exposed to low temperatures. On some sections of the New York Central Lines, the mercury drops during the wintertime to from 40 to 50 degrees below zero, and condensate might, under such conditions, lead to serious injury to essential conduits, etc.

While the actual blowing of the locomotive's whistle is done by steam, still the opening and the closing of the steam valve are effected pneumatically. This does away with the usual whistle rig—an air valve located near the side of the cab and immediately in front of the engineer taking its place. The bell ringer is also operated by compressed air. Sand from the sand-box on top of the boiler is forced, by compressed air, down through the connecting piping to points on the rails immediately in front of the driving wheels whenever it is necessary to improve the tractive contact between the wheels and the rails. The fire doors are opened and shut by levers which are actuated by the pistons of pneumatic cylinders. This provision lightens the work of the fireman and enables him to stand well clear of the doors while they are being moved. Heretofore, it has been customary to wet down coal with water under the impulse of a jet of steam, and more than once the hose nozzle has slewed around and caused the scalding of the fireman. In "No. 8,000" the cold water sprinkler is actuated by compressed air, and the foregoing menace is thus eliminated.

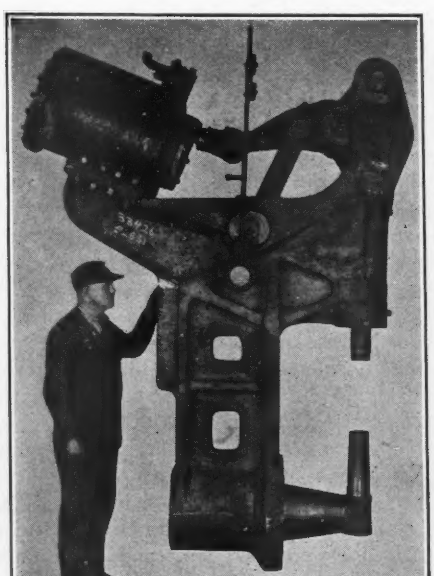
One can easily grasp that with the development of an engine possessing the tractive force of "No. 8,000," the proper working of the power reverse gear would present a fairly strenuous task for the engineman. The heavy parts of the mechanism could not easily be shifted by the ordinary lever without imposing a rather severe muscular drain on the man at the throttle. Therefore, it was decided to have recourse to an air-driven equipment which would do the work of the lever without calling for any effort on the part of the operator. The cylinder cocks both for venting the cylinders of the main and the booster engines are opened and closed pneumatically; and the admission of steam to the booster is similarly regulated by a steam valve which is opened and closed by compressed air.

Locomotive "No. 8,000" is equipped with a water scoop, which permits the engine to pick up water while underway from tanks placed at intervals between the tracks. This does away with the need of halting at watering stations, and allows the train to go steadily onward. The scoop on the super-locomotive is lowered and raised, as occasion requires, by suitable connections with a pneumatically moved piston.

In conclusion, it may be said that the diversified applications of compressed air have come about through the proved efficiency of this flexible medium in the manipulation first of the brakes, next in the forcing of sand from the sand-box down to the tracks, and then in the operation of the whistle valve. It is more than likely that the railroad engineer will find in the near future other directions in which he can employ pneumatic control on locomotives with a corresponding gain in economy and efficiency.

LATEST IN BOILER RIVETERS

RIVETING the last head in a boiler is a manufacturing problem which is met in various ways, and the procedure in many instances leaves much to be desired. A step forward in this art has latterly been made by the Hanna Engineering Works; and that concern a short while ago shipped from its plant a riveting machine designed especially for service in connection with the driving up of the last heads in boilers.



The new type of riveting machine designed especially for driving up the last heads in boilers.

The reach of this unit ranges from fourteen to eighteen inches; the gap is 35 inches; the cylinder diameter is eighteen inches; and the capacity is 100 tons. The die stroke is of 5¾ inches; and the total weight of the unit is 9,900 pounds.

The machine is arranged for portable use and to function in two positions. Suspension is made with the dies vertical, as shown in the accompanying illustration. The apparatus swivels about a point near its center of gravity, which permits the stationary dies to be swung on and off the manufactured head of the rivet in a direction very close to that of the line of die travel. Therefore, the mass or weight of the riveter is not lifted or lowered when riveting.

The stake is of forged alloy steel. The distance from the center of the beam stake to the end face of the die standing thereon is 30 inches, and this makes it possible to accommodate a 60-inch shell. The length of this die can be varied in conjunction with the opposite die to take care of shells of only 42 inches in diameter. The distance from the axis of the dies to the long face of the throat is sixteen inches. This machine has been built for use on high-pressure containers in which the rivets are 1¼ inches in diameter and the plates are 1½ inches thick.

It seems that machines of this type can be furnished with either a straight-push, hydraulic actuating mechanism or with the well-known Hanna pneumatic feature.

ICEBERGS

WHEN pieces of ice, little or big, come in contact, it is their habit to freeze together. Thus icebergs are formed from snowflakes. It is estimated that the weight of some of the bigger icebergs of the Atlantic is as much as 2,000,000,000 tons; and they not infrequently tower to a height of 1,000 feet above the waves which, at that, is but one-tenth of their bulk. To form one of these 'bergs may have taken 100 years; but, even so, they are only playthings for the Gulf Stream.

The candy industry in the United States is truly a large one, as evidenced by the sale of 2,000,000,000 pounds last year for $1,000,000,000. It will probably surprise many of us to learn that candy, especially chocolates, are improved by refrigeration.

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EDITORIALS

RAILWAYS OR MOTOR CARS WHICH SHALL IT BE?

THIS IS the question which, for the time being, is pressing in Norway for a satisfactory answer. That enterprising country has under consideration a program of transportation expansion that is to cover the next four decades; and the authorities are trying to determine whether it will be best to establish automobile routes or to build branch and local railway lines.

One of the experts of the committee appointed by the Storthing, the national legislative body, has announced "that a railway line cannot be justified from the economic point of view as compared with an automobile route unless an average yearly traffic of from 30,000 to 40,000 tons can be assured for the entire length of the railroad."

Further, the committee, as a whole, reports: "The tremendous development which has taken place during the past two years in automobile traffic is revolutionizing ideas about the utilization of a country highway as compared with the railroad. Reports from Denmark seem to indicate that competition by automobile routes has had a decided negative effect on the finances of the government railways. This is shown by the fact that the last increase in rates on the part of the railways, which was meant to bring about a balance in Denmark's national budget, has brought about a decided decrease in railway traffic in favor of the automobile."

While the traffic in these Scandinavian nations is small compared with that in some other countries, still kindred transportational problems are coming to the front elsewhere; and the automobile or motor truck within definite limits is bound to prove either a helpful feeder or a serious competitor of the established rail lines. For the handling of certain sorts of freight and for so-called short hauls the automotive vehicle has outstanding claims to recognition.

ATLANTIC-PACIFIC SHIPWAY ACROSS SOUTH AMERICA

CERTAIN of the South American countries lying below the equator are intent upon speeding up intercommunication through the creation of a canal which shall link the Atlantic with the Pacific across the continent in the neighborhood of the 47th parallel of latitude. This scheme was enthusiastically endorsed latterly by the International Congress of Engineers during the meeting at Rio de Janeiro. Just what the undertaking would involve has not yet been determined, but it is safe to say that it would call for the expenditure of more than $200,000,000.

One of the objects of the canal would be to obviate navigation along the storm-swept coast of much of Patagonia and the passage around treacherous Cape Horn, or through the Strait of Magellan; but the principal reason for the contemplated shipway would be to promote commercial intercourse between Argentina, Uruguay, Paraguay, and Brazil, on the eastern or Atlantic side of the continent, and Chile, Bolivia, Peru, and probably Ecuador on the western or Pacific half.

As matters have stood, the Panama Canal has not served to help the more southerly countries of South America owing to the long and not infrequently dangerous voyages necessitated in traversing the Isthmian route to and from the two oceans. Therefore, southern seafarers have fairly generally elected to make the shorter run around Cape Horn or through the Strait of Magellan in preference to the more circuitous trip via the Panama Canal.

Professor RODRIGUEZ DEL BUSTO, who has made a very careful study of the whole project, believes that the best line for the canal to follow—starting from the Pacific side, would be up the Rio Baker from Golfo de las Peñas to Lake Buenos Aires, the source of that stream; thence through the lake for a distance of more than 100 miles to where a branch of the Rio Deseado flows from the lake in a south and easterly direction; down the Rio Deseado to a point where it is proposed to join it by canal with the Sanguerr River; and then north along this stream to another canal that would be cut across the Patagonian plain eastward for about 50 miles to the Atlantic seaboard near Comodoro Rivadavia, on Golfo de San Jorge.

It is recommended by those interested that the area of Lake Buenos Aires be considerably increased by erecting dams and locks at its eastern end; and this increased volume of water is counted upon to contribute very largely to the water needs of the canal system to extend from there on across South America to the Atlantic. Lake Buenos Aires already is of great depth, and is fed by no less than 42 rivers and streams which drain portions of the neighboring snow-capped Andes. It seems that but little work would be required to render the lake navigable to shipping from end to end. Similarly, no engineering problems of moment would be entailed in canalizing the rivers lying between Lake Buenos Aires and the eastern terminus on Golfo de San Jorge.

The most troublesome phase of the scheme would, undoubtedly, be encountered in transforming the torrential Rio Baker into a navigable waterway throughout its length of 120 miles from the lake to its outlet. The plan agreed upon calls for an immense dam where the Rio Baker issues from the lake through a passage in the near-by mountains. This dam would serve to divert a part of the Rio Baker's waters into a canal which would be dug generally along the course of the river until the rapids and waterfalls were circumvented. For the last 50 miles of its lower course the Rio Baker is of sufficient depth to accommodate ocean-going craft of considerable draft.

Ambitious as this whole plan is, there is nothing to prevent its execution if funds for the purpose can be obtained. While a vast deal of excavational work would have to be done, much of it necessitating the drilling and the blasting of rock, still mechanical facilities are now available which are capable of dealing with tasks of this sort rapidly, efficiently, and economically. There are political reasons, aside from commercial ones, why the countries concerned should carry this scheme to consummation, and among these is the very natural desire for closer and more cordial relations which may be attained through easier means of travel and intercourse.

RUBBER TROUBLES UNELASTIC

ONE OF the most interesting and, in some of its phases, the most perplexing of the commercial and industrial problems of the day has to do with the production of rubber and its supply in reliable quantity and at a not unreasonable cost to the manufacturer. Curiously enough, the upsetting of things by the great war apparently had nothing to do with it.

The industries of the United States consume about 75 per cent. of the world's output of rubber, while British planters in the East Indies control 75 per cent. of the world's production. There is no occasion for any anxiety as to the maintenance of an adequate supply for all the world's wants, present or prospective; but there must be commensurate profits in sight for both the producer and the consumer. It is with the adjustment of the commercial conditions that the world is now most concerned.

The elasticity of the material does not yet seem to be available for easing the situation, which is of a decidedly uncomfortable aspect. Legislation in the East Indies is restricting the rubber output to 60 per cent. of plantation capacity, with permissible increases when certain prices are maintained, and American interests

are looking to the promotion of production in regions under their control. But these artificial adjustments, real or proposed, are only temporizing.

Where rubber is now produced the conditions are almost ideal, and there, in the interests of the wide world, we must expect production to continue, just as cotton and sugar have their inalienable habitats. Any trouble that may help us to forget the surviving complications of the World War may be looked upon as a blessing little disguised, and as leading us to a resumption of normal habits of thought and action. R.

THE PASSING OF ROENTGEN

THE RECENT DEATH of WILHELM KONRAD ROENTGEN, at the ripe age of 77 years, robbed the world of a physicist who will be remembered for all time because of his one amazing contribution to science. His is another example of how the man of the laboratory has stumbled upon some of Nature's secrets.

It was in 1895 that ROENTGEN discovered X-rays and showed that these invisible emanations from the well-known Crookes tube were capable of penetrating opaque substances and of revealing other bodies lying within or behind them. ROENTGEN was really engaged at the time in repeating experiments previously made by SIR WILLIAM CROOKES and others who had studied the action of electricity when discharged through highly exhausted tubes containing various gases. Curiously, none of these physicists was aware that he was utilizing an apparatus capable of generating X-rays.

On the occasion in question, ROENTGEN, for some reason, placed his vacuum tube in a black cardboard box which was a sufficient cloak to blanket the ordinary light produced by electrical discharges. However, while current was turned into the tube his eye was caught by a sheet of paper which had become strangely luminous. The paper was coated with barium platinocyanide. Searching about for a stimulating cause, ROENTGEN finally discovered that the phosphorescent glow continued as long as electricity was passing through his concealed vacuum tube. There was only one explanation: the tube sent out rays of a peculiar character which could pass through the walls of the pasteboard box and induce reaction in the metallic substance coating the paper. Afterwards, ROENTGEN found that the rays were capable of affecting a photographic plate and of producing shadowgraphs of metal objects placed in receptacles as well as of the bones of an interposed hand.

At first, the action of X-rays was deemed little short of uncanny; and for some time the belief prevailed among men of science that these rays were evidence of a hitherto unsuspected form of energy. We know today, however, that X-rays while akin to visible light rays are, in fact, of a wave length many million times shorter than those that consciously affect human vision. Thanks to X-rays, the unseen can be made apparent, hidden things can be brought to light, and the range of our eyes can be extended proportionately. For a number of years X-rays were scarcely more than a laboratory curiosity, a plaything of the inquiring man of science. The pioneer investigators were only dimly aware of the powers and the possibilities of these searching radiations—they did not grasp that they were virtually dealing with a weapon of limitless cutting edges. More than one of these experimenters has since paid a mortal price or has suffered the loss of fingers, a hand, or an arm, because of ignorance of the insidious destructiveness of Roentgen rays.

In latter years, much has been done to revolutionize the capabilities of the X-ray tube and to give to the operator powers of exquisite control while tremendously intensifying the penetrative reach of the rays, themselves. All of us know that the X-ray apparatus has given to the surgeon and the physician an invaluable weapon in battling with disease; and day by day both the physicist and the chemist are finding steadily broadening fields of application for this unique instrument. In short, we should be at a serious loss now if the X-ray tube were not at our disposal.

HOLIDAYS THE WORLD OVER

SOMEWHERE in the world there is a legal or a bank holiday, or a holiday of some sort, on 274 days out of the 365 in a year—just 81 days annually on which everybody works, aside from the shirkers. The Guaranty Trust Company, of New York, publishes a booklet each twelvemonth listing these "days off" chronologically, and by countries.

"There are no national legal holidays in the United States," says the Trust Company. "Each state or territory fixes by act of its legislature what days shall be legal holidays therein. The President's proclamation makes Thanksgiving Day a legal holiday only in the District of Columbia, although most states provide by law that any date appointed by the President as a day of fasting and prayer, or of thanksgiving, shall be a legal holiday in such states. The Governor of each state is usually given power to designate certain days as legal holidays by proclamation."

Election Day is expressly stated to be a legal holiday in the statutes of most of the states, but it is not a legal holiday in those that do not provide for it in this way. Many states have adopted the Negotiable Instruments Law which takes no account of the "Days of Grace," formerly so much in vogue. In Georgia, Massachusetts, New Hampshire, Rhode Island and North Carolina, however, if your note or sight draft fall due on a certain day, you are permitted to take advantage of several days of grace—usually three days, if you choose.

Brazil is by far the world leader in holidays. There are 22 national holidays in that republic besides 56 others set apart by the different states—78 in all. Turkey comes next, with 31; Spain, India, and Liberia follow with 27 each; Persia has 25 days of no work; the island of Fernando Po (Spanish) has 23, and Lithuania, 22. The average in the United States is about twelve. Does this mean that we are a harder-working people than others?

A large number of the world's holidays are religious ones, and there are many we know of that do not appear in the Trust Company's list. It seems odd that countries like Turkey, Persia, and the like, should set apart Easter, Christmas, and other Christian fête days for observance—and yet they do. There are numerous nations, however, that must publicly celebrate Christian, Mohammedan, and Buddhist holidays because their peoples practice different religions—thus adding to the list of rest days.

Curiously, in some countries, particularly in Central Europe and in the Near East, the old style of reckoning many religious dates is still adhered to. This makes such observances about ten days behind time. This recalls the story of the calendar. Just prior to the Christian Era, JULIUS CAESAR established what is known as the Julian Calendar, which lasted until the time of POPE GREGORY VIII., in 1582.

The Julian Calendar was just eleven minutes out of true annually with the astronomical year. By the time POPE GREGORY gave heed to the matter, the eleven minutes had grown to ten days. The Gregorian Calendar, which was then established, simply discarded these ter days and started anew with the calendar w now use, which was made to agree with the true astronomical year. For some unknown reason, however, a few of the Near Eastern countries still stick to the old Julian Calendar and celebrate their religious fasts and feasts according to its reckoning.

ALUNITE AND HENRY FORD

A YEAR and a half ago, COMPRESSED AIR MAGAZINE published an interesting article on alunite—a sort of pioneer story on that then little-known mineral, found only in the mountains of Utah, which forms the basis of three valuable commodities of commerce, viz.: potash, alumina, and sulphuric acid.

Since then, alunite has been more or less in the spotlight, and it is now generally recognized that in the extraction of either potash or alumina from alunite, the other two commodities can be produced as by-products at practically no additional cost.

HENRY FORD became interested, and he investigated alunite from A to Z. FORD wanted, and still wants Muscle Shoals, as everyone knows. He says, if Congress will let him have it, that he will create a vast industrial city at Florence, Ala., where he will give employment to thousands of workers in the manufacture of cheap potash for the farmers and cheap aluminum for use in his own automobile factories and elsewhere.

The potash industry is now held tight in the grip of the German Potash Syndicate. The aluminum industry of the world is controlled by a single company. FORD promises to break the strangle hold of both if he gets Muscle Shoals. Little wonder, then, that he is meeting with much opposition!

It first came out by inference, only, that Mr. FORD had alunite on his mind when he offered to do so many things at Muscle Shoals. His representative, whom he sent to Washington to appear before the congressional committees,

said nothing about that mineral. He did say, however, that his employer was prepared to manufacture large quantities of potash and of alumina from a single base; and it puzzled the Senators and Members of Congress because they knew of no substance capable of yielding these two products. To their knowledge, the only known source of alumina—the base of aluminum—was bauxite, and potash could not be derived from that material.

It remained for *Automotive Industries* to solve the riddle and to proclaim that it must be alunite that Mr. FORD's engineer had in mind, for the simple reason that it couldn't be anything else. The cat was thus let out of the bag

TURNING THE TABLES UPON THE BANKER

ONE OF THE features of a recent banquet given by the American Institute of Banking, at the Hotel Astor, New York City, was a very entertaining speech made by Mr. William L. Saunders, who is so widely known in the engineering world. In his inimitable way, Mr. Saunders managed to give the banking fraternity more than one humorous dig. The following story, which he told, is quite to the point.

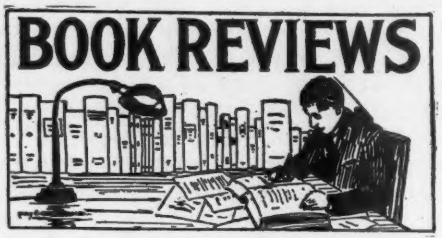
"After all, gentlemen, banking is a very simple science when compared with engineering. Even a negro can understand banking, but who ever heard of a colored engineer—at least not a colored civil engineer. Let me illustrate what I mean when I say that a negro understands banking.

"A colored laborer once put $10 in a New York savings bank. He later got a job in the South, where he worked for a period of twenty years. Returning to New York, he went to his bank to find that a new granite building had been erected. Going into the marble-walled corridor he was stopped by a big, black major-domo, in uniform and brass buttons, who rudely pushed him to the door, telling him that this was not the place for him but a bank where people come 'who has money.'

"The depositor resisted, saying, 'I'se got money in dis yer bank.' 'Yo got money yer! When has yo put money yer?' 'Twenty years ago I done put $10 in dis bank.' 'Go long, nigger,' said the bouncer, 'don't yo know dat da interest done eat up all dat principal long ago? Yo get out!' And the depositor went. That pompous darky was more than a bouncer: he was a banker."

A HEAVY QUARRY JOB

AN UNUSUAL job of quarrying "Deer Isle" granite was recently successfully accomplished at the quarry of the John L. Goss Corporation, Stonington, Mass. The stone in this quarry lies in horizontal sheets ranging from two to 30 feet in thickness, and a block was split off unbroken 220x20x8 feet, using 3½-inch plug wedges. More than 1,200 holes were drilled for the wedges, and there were also twelve powder holes five feet deep. These latter, with a very small charge of black powder, were fired at once by battery to loosen up the split at the seam so that the wedges could be taken out. The weight of the block is about 3,000 tons.



OXY-ACETYLENE WELDING AND CUTTING, by P. F. Willis. The sixth revised and enlarged edition, of 254 pages, with numerous illustrations. Published by The Norman W. Henley Publishing Company, New York. Price, $1.50.

THE OXY-ACETYLENE torch has amply established its usefulness in many departments of industry both for cutting and for welding, and a variety of operations are now performed with it that represent a marked saving in time and outlay. In fact, increasing knowledge of this agency opens up steadily widening fields of helpful application. The present work should be welcomed by thousands of persons engaged in divers productive and repair activities, because the author has gone to some pains to bring his subject thoroughly up to date. The book also treats of electric welding, which is a later departure in this specialized branch of metallurgy.

APPLIED BUSINESS FINANCE, by Edmond Earle Lincoln, M. A., Ph.D., sometime Assistant Professor of Finance, Graduate School of Business Administration, Harvard University. A book of 772 pages, published by A. W. Shaw Company, New York and Chicago. Price, $4.00.

THE WRITER says: "There would be little justification in writing one more book on the subject of business finance did not the author hope to present some new material and to survey from a somewhat different angle a considerable portion of the more commonly studied problems of finance. The aim of this book is to discuss those problems of business finance which actually arise from day to day in the average industrial concern, including both manufacturing and trading enterprises."

THE TWELVE-HOUR SHIFT IN INDUSTRY, by the Committee on Work-Periods in Continuous Industry of the Federated American Engineering Societies, with a foreword by the President of the United States. A volume of 302 pages, published by E. P. Dutton & Company, New York. Price, $3.50.

REGARDING the substitution of the 8-hour-shift system for the 12-hour-shift system, the findings of the Committee are expressed in this fashion: "There is practical unanimity of opinion in industry as to the desirability of the change provided the economic loss is not too great. The weight of evidence indicates that the change can usually be made at a small financial sacrifice on the part of the workers and of the management. Under proper conditions no economic loss need be suffered. In certain instances, indeed, both workers and stockholders have profited by the change. Facts developed by the investigation definitely prove that there is no broadly applicable way of striking a balance between the losses and gains inherent in the change from the 2-shift system of operation. If any one fact stands out above the others it is that the change cannot advantageously be made by fiat.

"Our judgment is that to effect the change suddenly or without adequate preparation is sure to cause lowered production. On the other hand, it is our judgment that when the change is pre-planned and the coöperation of everyone is enlisted gains will accrue to everyone concerned—to workers, management, owners, and the public."

ELECTRICITY IN AGRICULTURE, by Arthur H. Allen, Member of the Institution of Electrical Engineers, a book of 111 pages, with suitable illustrations. Published by Isaac Pitman & Sons, New York. Price, $0.85.

ELECTRICITY on the farm plays a far bigger part in the production of food and in adding to the comfort and the efficiency of the tiller of the soil than most people realize. Year by year, as transmission lines reach farther and farther into the rural districts lying around a source of electrical power, the utilization of this form of energy grows proportionately. To the general reader, chapter X of this book will probably be found of most suggestive interest, because therein the author discusses electroculture, that is to say, the use of electricity in stimulating plant growth.

There seems to be a fairly well-defined future for this employment of electricity, and there is no longer any doubt about the action of electricity in speeding up and in amplifying the growth of vegetable foodstuffs. For example, in 1912, electrified areas were employed in connection with experiments on potatoes, and an increased yield of 10¾ hundredweights was obtained per acre; in 1913 the increase was 13¾ hundredweights; and in 1914 the increase was one ton three hundredweights. As Mr. Allen points out: "It will be noticed that the increase is progressive, and it has been found that a plot which has been electrified in one year will again show an increased crop in the following year, although not then electrified, so that apparently some influence is exerted on the soil."

THE TALKING MACHINE INDUSTRY, by Ogilvie Mitchell, a book of 120 pages, with illustrations. Published by Isaac Pitman & Sons, New York. Price, $1.00.

THE TALKING machine, as a source of pleasure and diversion, has become a matter-of-fact commonplace. Few if any of the general public give a thought as to how these instruments are manufactured and the discs are made which record and reproduce the human voice and all sorts of music. Mr. Mitchell reveals these things, and tells his story in an entertaining way.

It is well known that the manufacture of iron and steel requires more power than any other single industry. In 1904, about 2,900,000 H. P. was so employed; in 1914, over 4,000,000 H. P.; and in 1919, something like 5,630,000 H. P. Attention is called to the use of electric drive in iron working. In 1904, it was 18.4 per cent. of the total power; in 1914, it amounted to 36.7 per cent.; and in 1919, about 50 per cent. Of course, the electric motor is not a source of power, but always has steam or water behind it.

A UNIQUE TUNNEL RECORD

THE public is generally much interested even in the preliminary announcements of the locating and the planning of tunnels and bridges; and the progress of such work always makes attractive news items. Quite unique is the story of one tunnel which was not heard of at all until after it had been put in service.

It was at Highlandtown, a suburb of Baltimore, where, according to the daily press, a tunnel 150 feet long, and big enough for a man to traverse, was recently driven from the cellar of an adjoining house to the storage warehouse of the Stewart Distilling Company.

We cannot learn that compressed air was employed, but competent engineering skill was evident in the lining of the passageway with timbers and in the penetrating of a heavy foundation wall. The operations must have occupied at least a month.

A pipe line was run through the tunnel; and, by the aid of a suction pump, the whiskey contents of more than 100 barrels were successfully abstracted and carted way, at night, in successive truck loads without attracting attention. The value secured is estimated at considerably more than $200,000. Not all tunneling enterprises can be expected to pay as well.

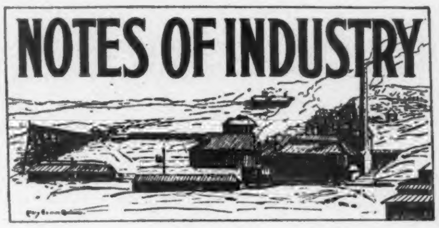
MODERNIZING THE HOLY LAND

PLANS are underway for the electrification of Palestine by raising the level of the Sea of Galilee and by harnessing the historic river Jordan. This same project, which is to involve an initial expenditure of $10,000,000, calls for the canalization of the Jordan valley, where abundant crops are to be grown by this system of irrigation.

The contemplated modernizing of the Holy Land includes the building of 2,000 miles of motor highways, the commercialization of the Bagdad-Cairo air route, agricultural credit banks, etc. With a population of but 700,000, Palestine imports $20,000,000 worth of commodities a year and serves as a trading base for 3,000,000 people in Asia Minor. Imports from the United States into Palestine have grown from an insignificant value of $292,000 ten years ago to a total of a little less than $2,000,000. As the population and the industrial development of the country increase, this region is bound to become an important world market.

AN OVERHEAD LOCOMOTIVE TURNTABLE

A TURNTABLE at the track level is a familiar accompaniment of the locomotive roundhouse for reversing engines on entering or leaving. At the repair shop of the Detroit, Toledo & Ironton Railroad, Detroit, Mich., there is a traveling crane which can lift a 100-ton locomotive and turn it end for end in one minute. There are two sets of falls, seven feet apart, for slinging the locomotive, and these falls are carried by a heavy turntable of small diameter which does the reversing.



Over $18,000,000 worth of minerals was taken from Alaskan mines in 1922. This brings the output figures back almost to those of prewar years.

In the quest of that world-sought fluid, petroleum, probably $30,000,000 is spent yearly in the United States in drilling operations which result in dry holes in the ground. In a period of two years, 5,814 dry holes were drilled in this country at an average cost of $10,000 per hole. Texas shows the highest percentage of dry holes, undoubtedly because of wildcat drilling, while California and New York have the lowest percentage of dry holes of all the oil-producing states.

New York City, according to the latest figures, has more than 47,000 factories that annually turn out products valued at something like $5,250,000,000.

The Post Office Department estimates that the business men of America suffer annually a loss of $1,740,000 on account of poorly and wrongly addressed mail.

The Mexican Government is shortly to open to foreign traders free ports at Puerto, Salina Cruz, and Guaymas.

It is customary to think of China as the most densely populated country in the world. This distinction, however, belongs to Belgium. While China has the largest population—428,000,000 people—it also covers the largest areas; but the number of its inhabitants to the square mile is only 99.96. Belgium has 666.22 inhabitants to the square mile!

In the last two decades the United States Government has built canals aggregating more than 13,000 miles.

The world's supply of jute is obtained almost entirely from northeastern India.

A rich quicksilver vein, which is said to extend over seven miles on the surface and to vary in width from two to six feet, has been discovered in Japan. Assays show the ore to contain 18 per cent. quicksilver; and preliminary excavations indicate that the vein increases in thickness the deeper it goes. Mining interests in northern Kyushu are to undertake the development.

Noticeable increases in the use of electric signs for advertising purposes are taking place in England. The development of this means of public display, however, does not begin to approach that in cities of similar size in the United States.

It will be several years, or more, before billions are in as common use in England as in the United States. An American billion is only a thousand millons, (1,000,000,000), while a British billion is a million millions (1,000,000,000,000). Only think of a billionaire, and in pounds instead of dollars!

In old, old England, so thoroughly undermined and dug into, a new coal field is being opened in the Dukeries district of Northamptonshire, and it is expected that it will add enormously to Great Britain's coal wealth. Six pit shafts are to be sunk; and some of them have been commenced. A company with an initial capital of $2,500,000 has been formed to develop deposits in Kent, an entirely different field. We are compelled to stop and consider the underground wealth we are unthinkingly tramping over in our own land.

More than $300,000,000 worth of paint and varnish is sold in the United States annually.

The Russian Railway Commission is reported to have contracted with the *Deutsche Werke*, in Germany, for the construction of a number of Diesel-engined locomotives. These new tractors are to cost approximately twice as much as steam locomotives; but, among other advantages, they may be operated without water. For Russia, where water is scarce in sections, this is a distinct improvement, and will permit the extension of railway lines into parts of that country where previously there were none.

While the United States far outstrips all other nations in the total annual consumption of electrical energy, the little Republic of Switzerland easily leads in the yearly per capita consumption, which amounts to 700 kilowatt-hours. Canada comes next, with 612 kilowatt-hours; Norway, with 493 kilowatt-hours; and the United States with 472 kilowatt-hours of electrical energy for each of its 110,000,000 inhabitants.

The fresh fruit and vegetable industry on the west coast of Mexico has grown so rapidly, reports the United States Department of Commerce, that plans have been prepared to establish ice and refrigerating plants in many towns along the Southern Pacific Railway in Mexico. This step is necessary to keep the increasing shipments of perishable foodstuffs in good condition en route in view of the fact that the present system of sending ice from Nogales, Ariz., to the shipping points in Mexico is inadequate.

Anniston, Ala., is putting itself on the map. It is manufacturing more soil and cast-iron pipe than any other city in the world. In the month of January, 1923, 1,200 carloads of pipe and fittings were shipped as well as 40 carloads of textile products. The Federal Phosphoric Company shipped 80 carloads of ferro-phosphorus and phosphoric acid; and has just perfected the manufacture of calcium arsenate from ore found in the Anniston district.

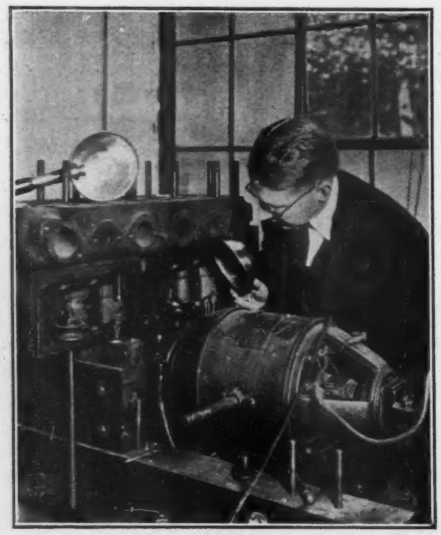
TAKING THE BLUR OUT OF SPEEDY MOTION

By G. H. DACY

A CURIOUS lamp, which makes things seem what they are not, is the latest addition to our valuable equipment of mechanical devices. Heretofore, it has been impossible to do anything but speculate concerning what was wrong with certain types of high-speed machinery which would not work. There was no efficient apparatus available for studying each movement of these rapidly moving mechanisms, many of which operate at the extraordinary speeds of from 10,000 to 20,000 or more revolutions a minute.

The new lamp reveals all the secrets of the activities of such high-speed appliances. The lamp is so equipped that it will make the flying needle, valve, or piston, for instance, look as though it were functioning at exactly one one-hundredth of the velocity at which it is actually moving. This novel lamp can be so adjusted that it will make the shifting part appear to be standing still or working at a snail's pace. It will also make a piece of machinery seem to be running in the opposite direction to that in which it is really going.

Many years of research have been required to develop and to perfect this unusual light, which is the invention of an English engineer; and it has already revolutionized certain forms of industry in England. The appliance is now being manufactured abroad, and it is likely that in time a branch factory will be established in the United States, as the demand for detecting lamps of this description in American industry is great. The United States Bureau of Standards, at Washington, has recently tested one of these scientific lanterns and found it to be one of the most efficient of the devices produced for the service mentioned. As a result of these investigations, Uncle Sam has purchased a number of them.



Under the flash of the lamp, operating parts of a mechanism that are moving 10,000 times a minute appear to be going at a rate of but 100 times a minute.

The unique apparatus, known as the "oscilloscope," consists of a gear box, which must be securely fastened to a rotating part of the machine to be examined, as well as of a 2-unit lamp, and a number of storage batteries, which operate it. The lamp slows down visually the motion of rapidly moving mechanisms so that their operations can be carefully studied. For example, the bobbin of a cotton spinning-machine which is really moving 10,000 times a minute looks, under the flash of the lamp, as though it were traveling but 100 times a minute. The part is made seemingly to shift so slowly by reason of the lamp that the engineer or mechanic can observe it closely and thus ascertain exactly what is wrong with it when it refuses to work properly. The device has proved its worth as a valuable aid in many industries, such as cotton spinning, textile printing, worsted spinning, weaving, paper printing, lace making, and in the moving-picture business. There are hundreds of other uses to which it may be adapted.

The oscilloscope, apparently, slows down the speed to such an extent that the movement of each part of a machine can easily be followed by the eye no matter how rapid it may actually be. By another function of the instrument, the operator can seemingly arrest motion altogether at any one point, making the mechanism appear to be stationary at that particular place even though it is really working at top speed. For example, if the propeller of an airplane is "idling" as the machine rests on the ground, you may stand in front of it and look at the revolving screw, but all that you can ordinarily see of the latter is a blur. If, however, you were aloft in an airship, and flying alongside a second 'plane, at almost the same speed, you would be able to see the rotating blades of the propeller of the other machine very distinctly. If you were traveling on a railroad train abreast of another train running at the same speed, the second train would look to you as if it were standing still. The scientific lamp is based on these phenomena.

The "lamp detective" is so delicately adjusted that it flashes at intervals as minute as one one-millionth of a second. Each time that it flashes, it shows the movement of the rotating or shifting part at a fixed point. The flashes occur with such regularity that each time the part being examined makes its hundredth movement in the cycle, the lamp lights it and shows it at a point directly above the one where it was the last time the hundredth motion was completed. It is this action which makes the parts appear to be going backward and forward or round and round at a much lower rate of speed. If the operating mechanism is to be shown at a standstill, the lamp flashes at the precise moment the part again arrives at a definite point in its course.

When a sewing machine is going at 1,500 revolutions a minute, the average picture of the machine in operation would represent the moving parts as mere blurs. However, a photograph taken under the rays of the oscilloscope, with the lamp adjusted to represent inaction, will give a distinct reproduction of the shifting parts which then look as though they were at rest. The lamp, therefore, is an aid to modern photography, as it renders it possible to expose ordinary negatives and to secure clear pictures under conditions that would otherwise make it extremely difficult if not impossible to get accurate reproductions.

In many textile factories, the use of the oscilloscope has speeded up production from 100 to 300 per cent. For example, in a calico print factory, before the new lamps were installed, the material passed in front of the operators at a velocity of only 100 feet a minute, as that was about the highest speed at which the workers could carefully observe the patterns. By aid of the oscilloscope, this progress, so far as the eye was concerned, seemed to be at the rate of but one foot a minute. Hence, all the machinery could be speeded up to greater output. Where the production of any given commodity is governed by the rate at which the eye can follow the process, such production can be increased a hundred-fold by the use of the oscilloscope.

The oscilloscope consists of a gear box, which must be securely fastened to a moving part of the machine, and of a unique 2-unit lamp with storage batteries to operate it.

The remarkable lamp is useful in "tuning up" the automobile and in determining how efficiently all the parts are working. It is valuable for examining crank cases of internal combustion engines. With it the valves of internal combustion engines, which are not bouncing properly on their seatings, can be located. Oil and lubricating systems, which are not functioning effectively, can be studied and repaired. The light is so sensitive that in spinning cotton it will reveal even the knots in the fiber that are not tied as they should be and it will also show just what is the trouble with the machinery that causes such defects in manufacture. With it, speedometers can be tested for accuracy, while mercury interrupters, which previously have been hard to examine, can now be thoroughly investigated. These are but a few of the innumerable uses to which the new lamp can be put—a far more curious lantern than that carried by Diogenes in his search for an honest man.

At the rate public automobile transportation is spreading, it will soon be possible to go around the world in motor buses.